Nova Scotia

Department of Mines and Energy

Information Series
No. 5

Sixth Annual Open House and Review of Activities

December 1 and 2, 1982

PROGRAM AND SUMMARIES

Honourable Ron Barkhouse, Minister
John J. Laffin, P.Eng., Deputy Minister

HALIFAX, NOVA SCOTIA
1982

TABLE OF CONTENTS

	Page
Foreword	v
Program	vii
Mineral Exploration Activity in Nova Scotia - 1982 - J. M. McMullin	1
Drill Core Library - J. M. Bingley	7
Industrial Minerals - J. H. Fowler	9
Aggregate Resources of Southwestern Nova Scotia - W. J. Wright	13
Mineral Inventory and Library - N. A. Lyttle	15
Sydney Basin Project - P. S. Giles	19
Loch Lomond Basin, Windsor Group Project - R. C. Boehner	25
Surficial Geology of the Western Part of Cumberland County, Nova Scotia - R. R. Stea	27
Geochemical Surveys - P. J. Rogers	33
Geology and Gold Deposits of the Goldenville Formation in the Region Between Sherbrooke and Sheet Harbour (Paper 1) - J. R. Henderson	35
Meguma Gold Project, Geological History of the Meguma Terrane in the Country Harbour Area, Guysborough County, Nova Scotia (Paper 2) - J. D. Keppie	36
A Structural Classification of Quartz Veins in Greenschist Facies Rocks, Meguma Group, Eastern Nova Scotia (Paper 3) - B. H. O'Brien	41
Relation of Gold to Quartz-Vein Polytypes in Greenschist Facies Turbidites, Meguma Group, Eastern Nova Scotia (Paper 4) - S. J. Haynes	44
General Geology of the Cochrane Hill Gold Deposit with a Clue to Relative Ages of Gold Generation (Paper 5) - P. K. Smith	46
Sedimentary Features of the Goldenville Formation, Sherbrooke Area, Nova Scotia (Paper 6) - J. W. F. Waldron	49
Mineral Deposit Studies Contrasting Granophile (Sn:W:Mo:Cu:U) Deposits of Nova Scotia - A. K. Chatterjee	53
Education and Public Awareness Program - H. V. Donohoe Jr.	57
Coal Exploration in the Sydney Coalfield in 1982 - D. J. MacNeil	59
Studies in the Springhill Coalfield - J. H. Calder and R. Naylor	63
Peatland Inventory - A. R. Anderson and W. Broughm	65
Oil and Gas Exploration Review Energy, Resources Division - D. J. MacDonald	69

FOREWORD

The opportunity to again present our Departmental review of activities comes at a time of extreme contrasts in the elements represented at this Sixth Annual Open House.

We are very pleased to provide details of the first full field season's activities related to a new two-year, $3.94 million, Energy, Mines and Resources Canada/Nova Scotia Department of Mines and Energy Mineral Development Agreement. This unprecedented new cooperative program provides financing for a number of new research projects covering the whole mineral resource spectrum, from regional surveys to mineral processing, from Cambrian gold deposits to Recent peat deposits, from computer terminals to core storage buildings. The major portion of the presentations herein documents the initial results of a number of these projects.

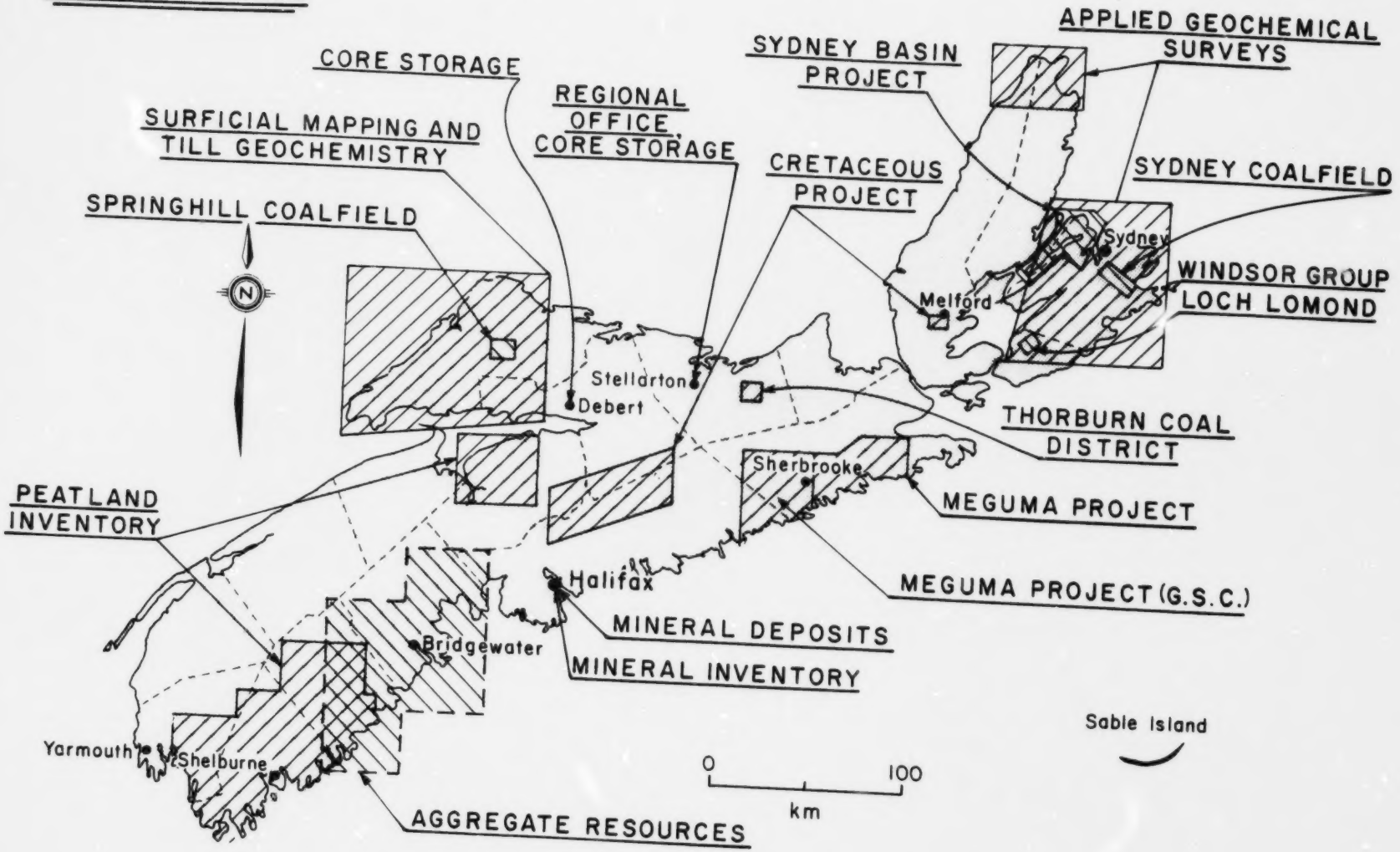
Similarly, the optimism expressed last year with respect to natural gas and petroleum exploration has been confirmed by the increasing number of drilling rigs currently active offshore. A review of Departmental activities related to this exploration is provided by staff of the Energy Resources Division, along with information on continuing coal exploration and development in the Sydney and Springhill coalfields.

However, contrasted with the resurgence of government mineral-related programs in 1982 was the most serious decline in Canada's mineral industry in the lifetime of most Open House participants. Although Nova Scotia's traditional mineral producers: coal, gypsum, salt, aggregate and limestone, have maintained operations to a large and commendable extent, mineral exploration and development suffered a 75 per cent decrease in the Province compared to the near record levels of 1981.

These are extremely difficult times. The one constant element in our local picture is the geology of Nova Scotia. The one improving element is the increasing understanding of our undeveloped mineral potential. We are optimistic that the mineral research summarized in this publication today will assist in the reactivation of industry exploration and development tomorrow.

J. A. Garnett, Ph.D., P. Eng.
Assistant Deputy Minister
Mines and Minerals

1982 PROGRAMS



Program

Nova Scotia Department of Mines and Energy

Sixth Annual Open House
and Review of Activities

WEDNESDAY, DECEMBER 1, 1982

14:00-17:00 REGISTRATION, POSTER DISPLAY, CASH BAR

19:00-20:00 REGISTRATION

20:00 WELCOME — Official Opening
20:05 MINISTER'S REMARKS
Hon. Ron Barkhouse
20:20 DEPUTY MINISTER'S REMARKS
John J. Laffin, P.Eng.
20:30 ASSISTANT DEPUTY MINISTER'S, MINES AND MINERALS, REMARKS
Jack Garnett, P.Eng.
20:40-22:30 INFORMAL DISCUSSIONS, POSTER DISPLAY, CASH BAR

THURSDAY, DECEMBER 2, 1982

08:40 PROGRAM INTRODUCTION
Jack Garnett, ADM Mines & Minerals
08:45 RESOURCE GEOLOGY SECTION OVERVIEW
Dan Murray, Manager
08:55 EXPLORATION ACTIVITIES
John McMullin
09:05 CORE LIBRARY PROGRAM
Jim Bingley
09:10 INDUSTRIAL MINERALS
John Fowler
09:20 MINERAL INVENTORY
Norman Lyttle
09:30 PROJECT GEOLOGY SECTION OVERVIEW
Duncan Keppie, Manager
09:35 CARBONIFEROUS BASIN STUDIES
Peter Giles
09:45 CARBONIFEROUS STUDIES
Bob Boehner
09:55 PLEISTOCENE PROJECT
Ralph Stea
10:05 GEOCHEMISTRY
Peter Rogers

10:15-10:40 COFFEE BREAK

MEGUMA GOLD PROJECT
10:40 Jack Henderson (GSC)
10:50 Duncan Keppie
11:00 Brian O'Brien
11:10 Simon Haynes
11:20 Paul Smith
11:30 John Waldron (St. Mary's University)

11:40 METALLOGENESIS
A.K. Chatterjee
11:50 EDUCATION AND PUBLIC AWARENESS PROGRAM
Howard Donohoe
12:00 ENGINEERING DIVISION
Pat Phelan, P.Eng., Director
12:10 ENERGY RESOURCES DIVISION
Rick Hornby, P.Eng., Director
12:15 COAL AND PEAT EXPLORATION REVIEW
Kevin Gillis
12:25 OIL AND GAS EXPLORATION REVIEW
Jack MacDonald

12:35-13:20 LUNCH

13:20-17:00 INFORMAL DISCUSSIONS, POSTER DISPLAY, CASH BAR

Map and sample displays will be available throughout the program. Staff will be available for discussion. Current Department publications will be on display and available for purchase.

MINERAL EXPLORATION ACTIVITY IN NOVA Scotia - 1982

J. M. McMullin

In general, exploration activity decreased considerably from last years levels. All commodities experienced the downturn, with the exception of barite which has become a much sought-after mineral because of the increasing level of oil and gas exploration off the east coast. No uranium exploration was carried out in 1982 due to the moratorium announced by the provincial government in September 1981. Uranium exploration in 1981 totalled $3.7 million.

Many of the exploration projects which should have continued during 1982 were severely cut due to budget restrictions or postponed due to lack of financing. Some of the projects are still on hold, while others have only recently been able to get under way. The decision by Shell Resources and Gulf Minerals to disband their minerals exploration divisions has removed two of the larger operators from the scene, although Shell did in fact carry out a very substantial program in Yarmouth and Queens Counties before they pulled out. The two companies other than Shell and Gulf which still held substantial areas for uranium exploration, namely Saarberg Interplan and Kidd Creek Mines, were severely restricted in their activities because of the uranium moratorium.

Newcomers to the Province include Selco and Billiton. Billiton has taken over some of Shell's licences as well as staking new ground. The East Kemptville tin deposit and adjacent licences have been taken up by Rio Algom.

GOLD EXPLORATION

Activity in 1982 was down very substantially from the $2 million spent on exploration and the $1.5 million spent on property development during 1981. Northumberland Mines shut down their milling operation at Cochrane Hill during the spring and are now evaluating a cyanide leaching technique. Louisbourg Property Holdings also suspended operations in the early spring at Mile Lake. No further major work was done at Harrigan Cove. Major programs by Patino in the Seal Harbour area and by Pan East Resources in central Nova Scotia and the eastern shore have been on hold due to lack of funds. An ambitious exploration program by Seabright Resources at Forest Hill eventually got under way after being delayed most of the year (Fig. 1). Seabright is also proceeding with plans to reclaim gold from old mill tailings at various places in the Province. Limited underground development work was carried out by Edgar Horne and Byron Taylor at Renfrew, along with a drilling program conducted by Borcan Resources. Drilling for gold and/or precious metals has also been carried out during 1982 by Noranda at Dunbrack, Halifax County, by Dome Exploration at Second Gold Brook, Victoria County and by Whiteburn Precious Metals at Whiteburn, Queens County. Trenching has been carried out by Fifteen Mile Stream Mining Company at Fifteen Mile Stream, Halifax County and Hi Pockets Exploration are evaluating a property at Round Lake on the Queens County-Annapolis County boundary.

BASE METALS

Tin and tungsten exploration is continuing, but at a slower pace than in 1981. The most active groups in 1982 have been Shell, Esso and

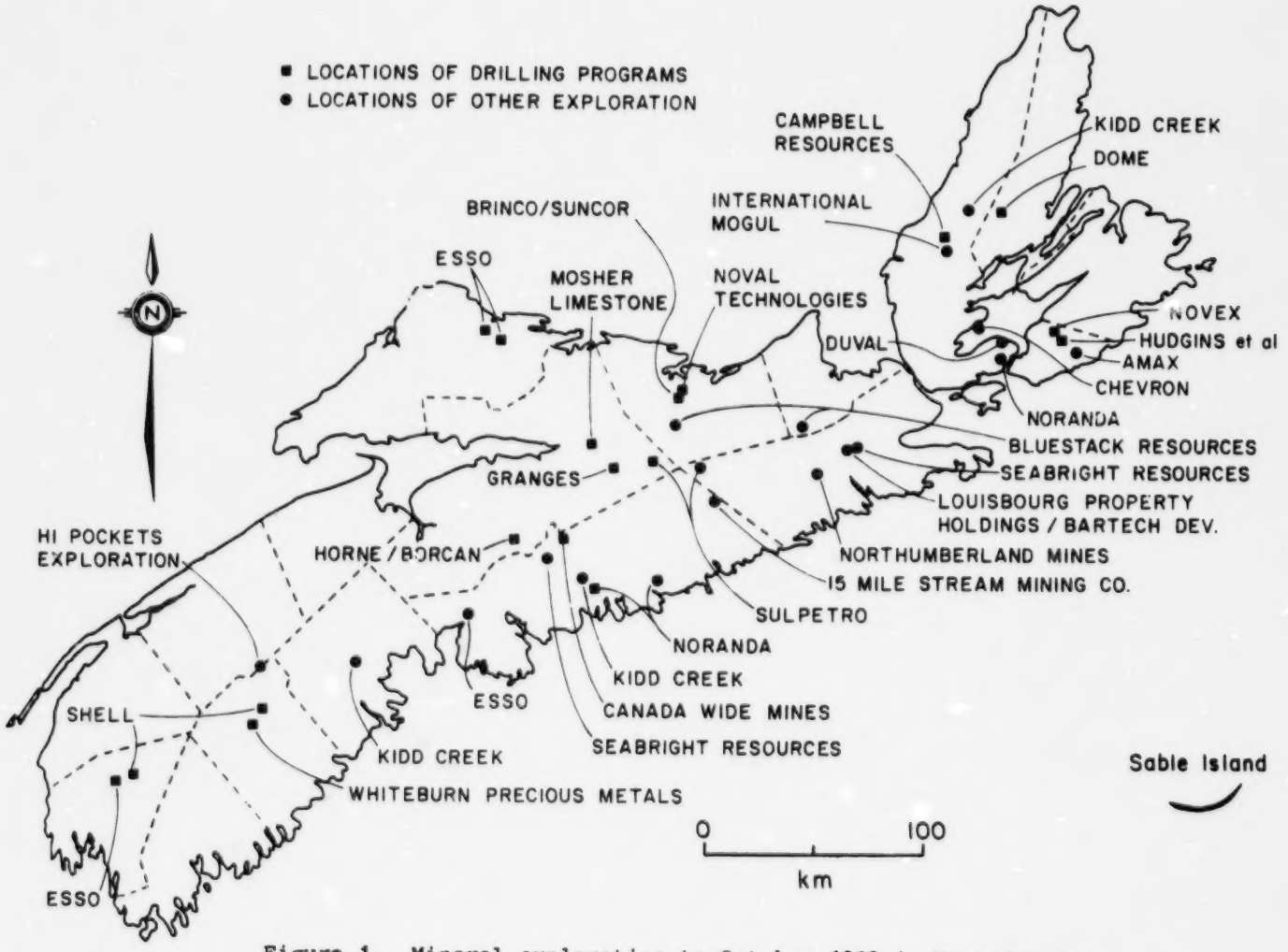


Figure 1. Mineral exploration to October 1982 in Nova Scotia.

Kidd Creek Mines (Fig. 1). An intensive diamond drilling and overburden drilling program was conducted by Shell in the East Kemptville area of Yarmouth County during the spring, and this exploration plan (along with the large low grade tin deposit previously outlined) has been taken over by Rio Algom Mines Limited.

A drilling program was also carried out by Shell at Calendonia, Queens County, which is one of the properties transferred to Billiton.

Esso Minerals continued exploration for tin on their Pearl Lake-Kemptville, Yarmouth County and Tantallon, Halifax County properties, and Kidd Creek were active in the Musquodoboit batholith and in the Sherbrooke Lake area of Lunenburg County. Sulpetro Minerals were active in the Trafalgar area, Guysborough County.

Copper, lead, zinc exploration was also at a lower level during 1982. Esso have been drilling in the Carboniferous in the Pugwash area of Cumberland County and also did some drilling on the Gays River mine property to establish reserves for a possible open-pit operation. The Gays River mine has now closed permanently. Bluestack Resources have been conducting extensive geochemical survey work in the northeastern mainland areas of Pictou and Antigonish Counties for base metals and barite (Fig. 1). Further drilling was carried out in the early summer by Sulpetro on their Eastville, Colchester County area and by Granges Exploration at Smithfield, Colchester County. Amax have also become a victim of the recession. A modest exploration project was carried out by Amax in the Precambrian and Cambrian sedimentary/volcanogenic terrane southwest of Framboise, Richmond County, but they have now closed their regional exploration office in Sackville, New Brunswick and are not active at present. Also in Cape Breton, Duval continued some field work on the Sporting Mountain property, near St. Peters, Richmond County (Fig. 1).

INDUSTRIAL MINERALS

Potash

Exploration for potash has been extremely limited in 1982 and no drilling has been carried out. Cominco have postphoned plans to drill in the Kennetcook, Hants County area. Noranda carried out geological studies on their Ashfield and St. Peters areas in Cape Breton, and Chevron Canada Limited restricted their activities to a gravity survey in the West Bay area of Bras d'Or Lake (Fig. 1). Total expenditures in 1982 will be greatly reduced from the $2.3 million spent on potash exploration in 1981.

Barite

Campbell Resources carried out a geochemical sampling, trenching and drilling program at Scotsville, Lake Ainslie, Inverness County, and nearby, International Mogul Mines took out a bulk sample from their property at Trout Brook (Fig. 1).

Also in Cape Breton, Novex Mining and Exploration Limited have carried out a Winkie-drilling program at Lake Uist on the Pine Brook property and have purchased the former Yava Mill (previously Kaiser Celestite)

at Loch Lomond to beneficiate the barite ore, with production anticipated in the near future.

Many of the known barite showings in the Province are now held under licence by various individuals and companies.

Limestone

Mosher Limestone have been actively seeking new sources of limestone and carried out a drilling program in the East Mountain area near Truro, Colchester County (Fig. 1).

Silica Sand

Evaluation drilling has recently been undertaken by the Department on a thick sand deposit of probable Cretaceous age at Diogenes Brook, near Melford, Inverness County.

COAL

Brinco continued deep drilling in Stellarton, Pictou County during the early part of the year and this exploration program was later continued by Brinco's joint venture partner Suncor, who carried out a seismic survey for subsurface structural analysis (Fig. 1).

The Department of Mines and Energy continued drilling programs on the Tracy and Gardiner seams in the Sydney coalfield, and at Springhill, Cumberland County.

NATURAL GAS

Noval Technologies continued to test and evaluate several wells drilled for potentially commercial demethanation of coal seams in the Pictou coalfield, and drilled one more test well in New Glasgow during the summer (Fig. 1).

BLUE FORMS

As an aid to monitoring exploration activity and in order to provide dependable figures to indicate the health of the exploration industry in Nova Scotia, a new procedure was adopted at the end of 1981 to gather pertinent data.

A form to "Report all Physical Work and Surveys Performed in the Province of Nova Scotia" was distributed in January 1982 to those active in the Province in 1981 with a request to complete and return by mid-February, so that this information would be available as early as possible. Although some of the forms were not returned until much later, the overall response was very gratifying with 92 per cent of the questionnaires returned. The data are useful for summarizing the level of activity in the Province from year to year, and also are most useful for summarizing the actual programs, and drilling programs in particular, to identify areas where core may be available for the new core library in Stellarton.

This year we intend to distribute the forms prior to the end of the year to provide more time for their completion. It should be noted by those receiving them that they should be returned (appropriately notated) even if no work has been carried out and also that the exact dollar figures are not as vital as is receiving the general information promptly. A breakdown of the 1981 figures will be enclosed with the blank forms for 1982, and the 1982 breakdown should be available shortly after the return of the forms is complete.

The information requested is in addition to assessment report submissions, so that a compilation of data for work done during each calendar year period, rather than during each assessment/licence year may be put together. The previous system of totalling expenditures reported for assessment work was not satisfactory because of the varied dates of licence years, and also because excess assessment expenditures were not always reported.

DRILL CORE LIBRARY

J. M. Bingley

Until recently, government core storage programs were given a rather low priority by most provincial governments. This priority changed however, at the 37th Annual Conference of Provincial Ministers of Mines (1980), when a report from the Standing Committee of Provincial Geologists strongly endorsed the principle of government involvement in these programs. Subsequent to that meeting both federal and provincial funds have become more readily available for implementation of core storage programs.

Nova Scotia had maintained some core storage capacity for many years, but space was not available to retain more than the amount of core generated by our own drilling division. This cumulative amount together with some company core, is approximately 76 200 m of core that is partially stored out-of-doors. In anticipation of additional protected space being available, and to facilitate rapid handling of cores, a fork-lift truck was purchased in 1979. It was not until a federal-provincial agreement provided funding in late 1981 however, that new buildings could be planned and retrieval of company cores could begin. As of Autumn 1982 approximately 60 960 m of company drill cores have been assembled awaiting the building of new facilities.

The new facility, now nearing completion in Stellarton, consists of three steel-clad arch rib structures each measuring 15.8 m by 48.8 m. The combined core capacity will be approximately 304 800 m. All core will be stored on pallets and catalogued by the NTS system.

To minimize man-handling heavy boxes, individually complete holes will be transported by fork lift truck to a 111 m^2 laboratory incorporated into the first building. Large, roller-topped examination tables will permit rapid movement of core boxes. The laboratory will be the only part of the buildings that will be heated. Core splitters, diamond saws, a low power microscope and related laboratory equipment will be available at this location.

As mentioned previously core will be stored on pallets and indexed by NTS map number (e.g. 11E/10A) and where possible by tract and claim as well. An individual file card will be kept for each hole and this card will indicate the place name, the company that had the drilling done, the company's hole designation, the drilling company, the depth of the hole, and other pertinent data. Core logs will be kept on file if they are available in assessment reports or made available from other sources.

In addition to the above-mentioned information that will be retained in the storage facility, a catalogue will be kept that lists all of the drill cores stored and considerable pertinent data. This catalogue will be updated annually and made available to the public.

INDUSTRIAL MINERALS

J. H. Fowler

Overall production value of industrial mineral commodities for 1982 is expected to be lower than 1981 because of the downturn in the economy. This lull in activity offered many producers an opportunity to explore for new deposits, formulate development plans for reserves or probe the possibilities of expansion into other commodity markets. Commodities receiving such attention include gypsum, limestone, dolomite, silica sand and aggregates (Fig. 1).

Barite highlights industrial mineral exploration activity. Local demand is at an all time high because of offshore oil and gas well drilling. Most of the known barite occurrences have been started with exploration programs underway at several locations. Activities directed toward known barite deposits include metallurgical testing and market analysis.

CRETACEOUS PROJECT

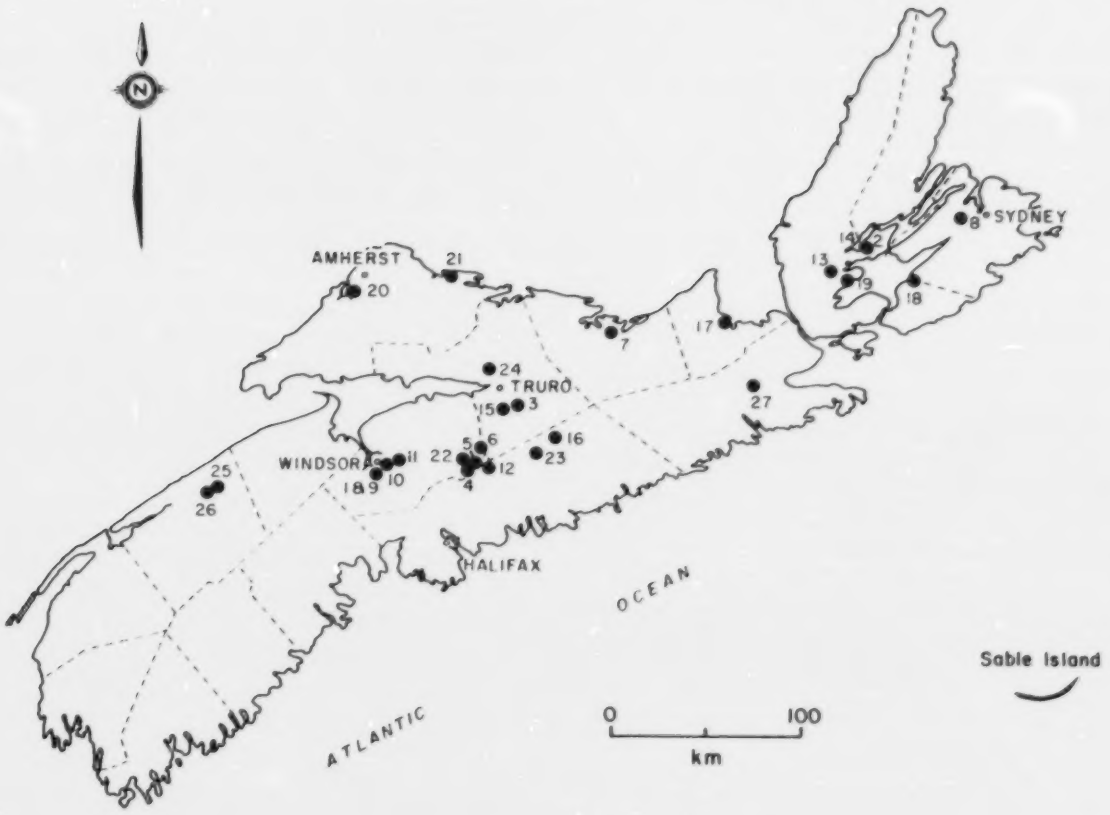
This is a project to ascertain the stratigraphy, relationship to bedrock and economic significance of the Cretaceous clay and silica sand deposits of central mainland Nova Scotia and southern Cape Breton.

In March of this year, Federal funds provided through a Federal-Provincial Mineral Development Agreement allowed for the completion of two diamond-drill holes in Cretaceous sediments at Elmsvale, Halifax County. This is significant in that it was the first time these deposits were "cored" from top to bottom. On the north side of the Musquodoboit Valley, DDH PB82-1 intersected refractory grade clay interbedded with silica sand from 3.4 m to 113.0 m . Bedrock at 113.0 m was laminated gypsum and limestone. South of the Musquodoboit River DDH EL82-1 intersected similar deposits from 9.0 m to 81.7 m. Intercalated mudstone, siltstone and limestone occurs below 81.7 m (Fig. 2).

In May a geologist was hired under contract to continue the Cretaceous program. To date all known silica sand deposits have been sampled for heavy mineral analysis, sieve analysis and petrographic work. A total of 13.3 km of Refraction Seismic work has been completed along six lines across the Musquodoboit Valley in the Middle Musquodoboit-Elmsvale district of Halifax County. Results show the depth to bedrock at Elmsvale varies from 18 m to 167 m over a horizontal distance of 300 m. The depth to bedrock is greatest along the north side of the valley. A diamond-drill program is slated for the deepest sections of the valley to determine the thickness and stratigraphy of the Cretaceous deposits. At Diogenes Brook (Glen Brook) in the vicinity of Melford, Inverness County diamond drilling is underway on suspected Cretaceous deposits found in the valley of the brook.

Contributing significantly to the understanding of the Cretaceous deposits of Nova Scotia is the palynological work on core samples from the two drillholes completed at Elmsvale earlier this year. This work is being done by the Eastern Petroleum Geology Section of the Atlantic Geoscience Centre at the Bedford Institute of Oceanography.

A report is being prepared on the Cretaceous deposits of Nova Scotia.



INDUSTRIAL MINERAL PRODUCERS

ANHYDRITE
1,10. Fundy Gypsum Co. Ltd.
2. Little Narrows Gypsum Co. Ltd.

BARITE
3. Nystone Chemicals Ltd.

CLAY AND SHALE
4-7. L. E. Shaw Ltd.

DOLOMITE
8. Scotia Limestone Ltd.

GYPSUM
9-10. Fundy Gypsum Co. Ltd.
11. Domtar Construction Materials
12. National Gypsum Canada Ltd.
13. Georgia Pacific Corp. Bestwall Division
14. Little Narrows Gypsum Co. Ltd.

LIMESTONE
15. Canada Cement Lafarge Co. Ltd.
16. Mosher Limestone Co. Ltd
17. Ridge Brokers Ltd.
18. Scotia Limestone Ltd.
19. Nova Scotia Sand and Gravel

SALT
20. Sifto Salt Division, Domtar Chemicals Group
21. Canadian Salt Company Ltd.

SILICA SAND
22-24. Nova Scotia Sand and Gravel

STONE
25. Heritage Memorials
26. A. & R. Nixon Granite Works Ltd.
27. Arsenault Monumental Works Ltd.

Figure 1. Industrial mineral producers in Nova Scotia, 1982.

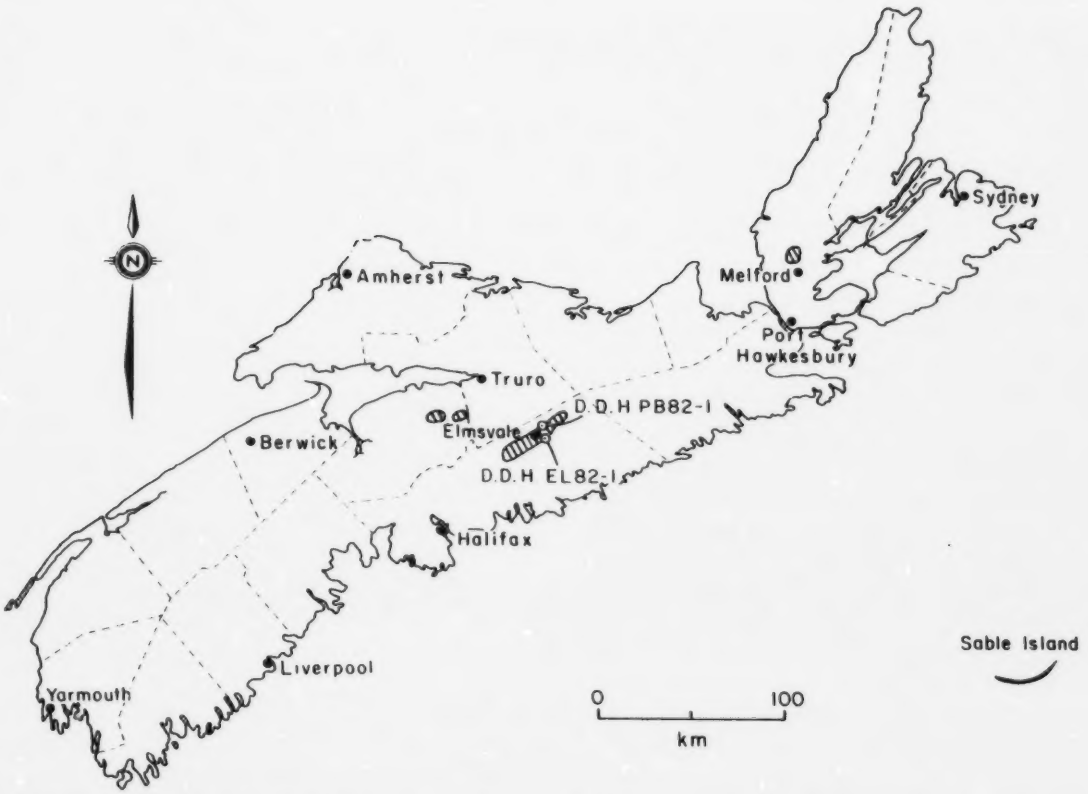


Figure 2. Areas of Cretaceous clay and silica sand deposits and location of two drillholes at Elmsvale, Halifax County.

AGGREGATE RESOURCES OF SOUTHWESTERN NOVA SCOTIA

W. J. Wright

The purpose of this survey is to identify all granular and bedrock aggregate resources within the study area. It is the intention of this survey to provide information on the location, quality and quantity of extractable materials and to identify bedrock sites suitable for aggregate quarry operations.

The 1982 study area covers the 1:50 000 national topographic map sheets indicated in Figure 1.

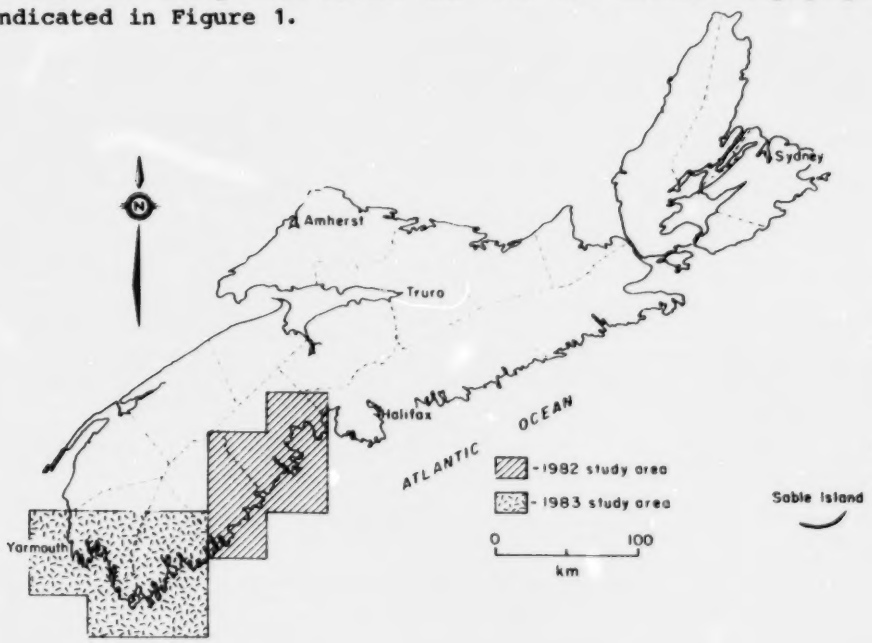


Figure 1. Locations of the 1982 and 1983 study areas.

Available information on the surficial geology of the study area such as aerial photographs, theses, assessment files (diamond-drill hole logs), bedrock geology maps, and aggregate producer data has been researched.

The glaciofluvial and bedrock samples collected will be tested for soundness, abrasion resistance, organic content and size gradings.

Geophysical work such as resistivity or seismic may be employed at a later date to help assess certain deposits.

Information gathered during the field season has been plotted on 1:50 000 N.T.S. map sheets and the final product will consist of 1:100 000 scale maps with a report.

MINERAL INVENTORY AND LIBRARY

N. A. Lyttle

REPORTS PUBLISHED IN 1982

Over the past two years, we concentrated our activities upon entering and updating NSDME document data in GEOSCAN, the national bibliographic data base for geological information. As a result of these efforts, we published eight reports in 1982. These reports are:

Report 81-4 *Index to Assessment Reports 1864-1980*

Report 81-5 *Keyword Index to Assessment Reports in NSDME Report 81-4*

Report 81-6 *Index to NSDME Publications, Open File Reports and Theses 1862-1980*

Report 81-7 *Index to Drillhole and Well Data 1862-1980*

Report 82-2 *Index to Assessment Reports 1981 (with Keyword Index)*

Report 82-3 *Keyword Index to Publications in NSDME Report 81-6*

Report 82-4 *Keyword Index to Open File Reports in NSDME Report 81-6*

Report 82-5 *Keyword Index to Geological Survey of Canada Documents on Nova Scotia to 1980*

REPORTS IN PREPARATION

Early in 1983 we expect to publish the Index to Assessment Reports for 1982, and the Index to NSDME Publications, Open File Reports, Theses and Geological Survey of Canada Documents on Nova Scotia for 1981 and 1982.

CANADA-NOVA SCOTIA COOPERATIVE MINERAL PROGRAM 1981-1984

Funds were obtained to finance three new projects in 1982 through a new Federal-Provincial agreement, the Canada-Nova Scotia Cooperative Mineral Program 1981-1984. Funds from the Canada Department of Energy, Mines and Resources are financing the GEOSCAN Updating Project and the Metallic Minerals Updating Project; and funds from the Province of Nova Scotia are financing the Drillhole Database Project.

GEOSCAN Updating Project

David Hopper was hired on a one-year contract to code and enter into GEOSCAN the subject contents of all geoscience theses on Nova Scotia that are cited in *Report 81-6 Index to NSDME Publications, Open File*

Reports and Theses 1862-1980. In addition, if there is sufficient time in the contract, he will code and enter into GEOSCAN all journal literature on the geoscience of Nova Scotia. Two computer terminals, required for on-line data entry into GEOSCAN, have been rented for two years using EMR funds, under the terms of this agreement.

Metallic Minerals Updating Project

Karen White-Smith was hired on a one-year contract to check and update the manual metallic mineral occurrences database. This project involves the checking of previously compiled metallic mineral occurrences cards, and compiling new cards from a variety of post-1977 documents. Ultimately, it is hoped that the manual metallic mineral occurrences database will be entered into a computer-based data management system, and be available for on-line searching and data retrieval.

Drillhole Database Project

Report 81-7 Index to Drillhole and Well Data 1862-1980 lists by map sheet the titles of all NSDME documents (Assessment Reports, Open File Reports, Publications and Theses) that contain information on drilling in Nova Scotia. The majority of these titles refer to drilling on land for mineral exploration. *Report 81-7* provides sources of drilling information but not the actual drilling data. To provide a means of rapidly retrieving, sorting and manipulating the drillhole data in the documents cited in *Report 81-7*, a computer based drillhole database was developed with the cooperation of the Information Division of the Maritime Resource Management Service.

For each drillhole, data are recorded under the following twenty-eight parameters: NTS Map, NSDME Drillhole Number, Claim Reference Map, Tract, Claim, County, UTM Zone, Easting, Northing, Latitude, Longitude, Mineralization, Commodity, Assay, Reference, Licensee, Exploration Company, Company Drillhole Number, Drilling Company, Year Drilled, Hole Depth, Collar Elevation, Penetration, Drillhole Sample Type, Drillhole Sample Location, Drillhole Logs, Drillhole Sections, and Paleontology. The database can be searched on all of these parameters, or any combination of individual parameters, and the resulting information printed out at a computer terminal. In addition, by using a drum plotter, computer generated drillhole location maps at variable scales can be produced. For example, a tabular printout for all twenty-eight parameters could be obtained for all drillholes on map 11D/12, and an outline map generated with all the drillholes for that map area plotted on it. A more narrowly defined search could be used to identify and printout data on drillholes containing gold mineralization on Map 11D/12 with the generation of the corresponding drillhole location map.

The coding and data entry for this drillhole project commenced in the summer of 1982 with the hiring of two summer students. Because of the large numbers of drillholes involved, our coding efforts were confined to drillholes described in the assessment reports cited in *Report 81-7* . To date, coding and data entry has been completed for all drillholes in map sheets 11D, 11E/01, 11E/02, 11E/03, 11E/04, 11F/03, 11F/04, 11F/05, 11F/06, 11F/07, 11F/09, 11F/10, 11F/11, 11F/12 and 11F/13.

LIBRARY

During 1982 renovations to the library resulted in major improvements which directly benefit users of the library. Floor space nearly doubled, and new shelving for our collections and periodicals, and arc files for maps were installed. Additional tables were added to provide more work areas. Two new microfilm reader-printers were purchased, and all three reader-printers were housed in individual study carrells to provide more privacy.

In 1981, a contract librarian was hired to catalogue and classify our library holdings. This activity is continuing, and to date approximately 50 per cent of our holdings have been catalogued and classified. A card catalogue now exists for the library holdings, providing title/author and subject files, thus facilitating rapid access to a wide variety of geoscience reference material.

ASSESSMENT REPORTS AND OPEN FILE REPORTS FOR 1982

For the year 1982, approximately 134 Assessment Reports and 55 Open File Reports will have been released. All these reports will be microfilmed and can be consulted in the libraries of the Halifax and Stellarton offices. These reports can also be purchased on microfiche directly from Precision Microfilming Services, 6061 Young Street, Halifax, Nova Scotia, B3K 2A3 (902 455-5451). Lists of the 1982 Assessment Reports and Open File Reports will be published in the 1982 Report of Activities of the Mineral Resources Division which is due for release early in 1983.

SYDNEY BASIN PROJECT

P. S. Giles

INTRODUCTION

Geological studies of Carboniferous rocks in the Sydney Basin, Cape Breton Island, Nova Scotia, were initiated in May 1982 as part of the Canada-Nova Scotia Cooperative Mineral Program (CNSCMP). Staff of the Nova Scotia Department of Mines and Energy undertook stratigraphic and structural studies in that area stretching from Sydney Harbour northwesterly to the Great Bras d'Or (Figs. 1 and 2) and southwesterly to include the Scotch Lake-Frenchvale extension of the Sydney Harbour Syncline, as well as Boularderie Island.

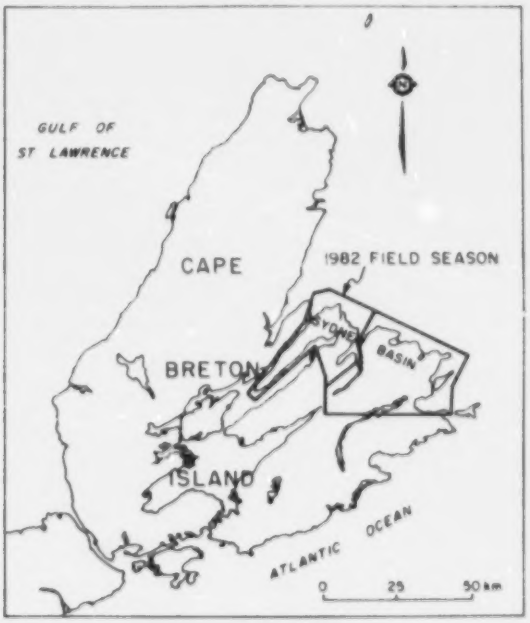


Figure 1. Location map, Sydney Basin project.

Concurrently, Dr. Brian Rust of the University of Ottawa and Dr. Martin Gibling of Dalhousie University undertook detailed sedimentological analyses of the lower part of the Morien Group, studying well-exposed coastal sections throughout the Sydney Basin. Selected sections of the lower Morien were studied in detail by Sean Dilles of the University of Ottawa in work leading to a M.Sc. degree. Similar detailed and comprehensive sedimentological analyses of the upper part of the Morien Group were continued by Guy Masson as part of his doctoral dissertation in progress at the University of Ottawa.

This sedimentological research, supplemented by comprehensive basin analyses using the entire Carboniferous succession, should permit significant advances in the geological understanding of the Sydney Basin.

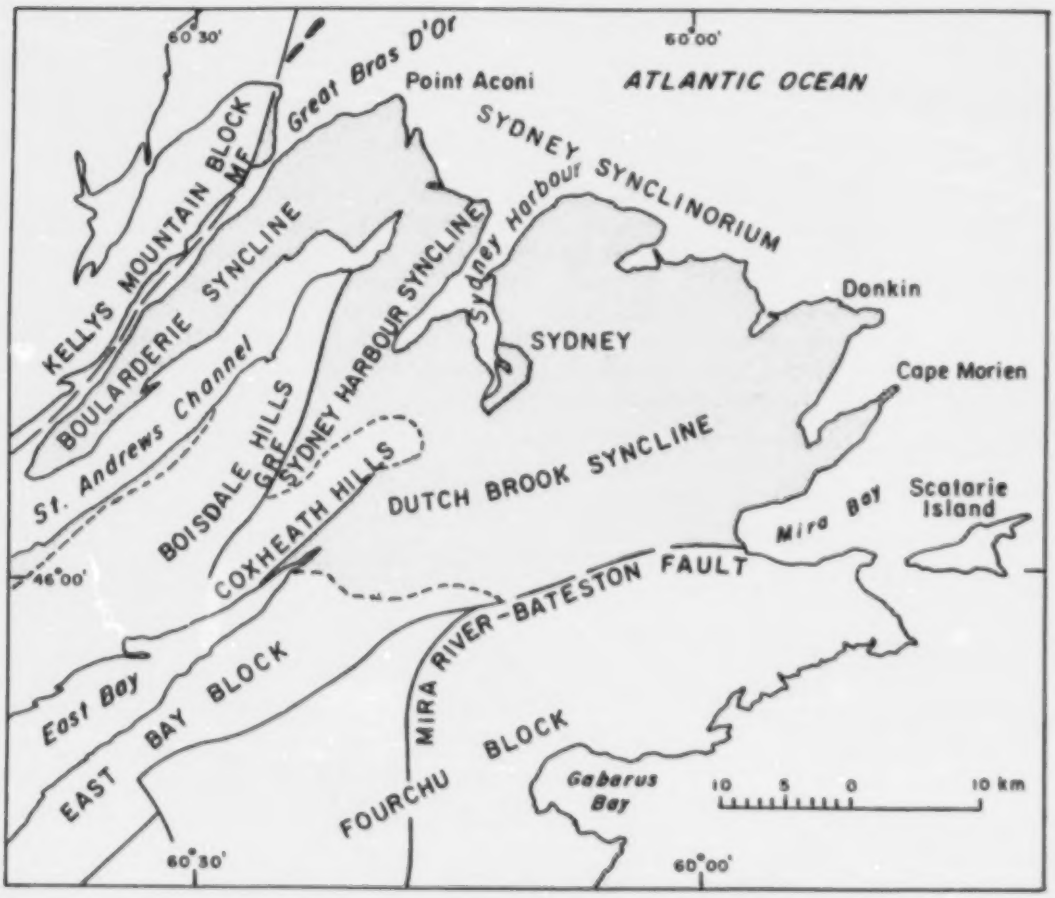


Figure 2. General geological setting of the Sydney Basin. Carboniferous rocks in grey; MF = Mountain Fault; GRF = George River Fault (nomenclature slightly modified from Keppie, 1982).

Some preliminary findings are summarized in subsequent paragraphs. More detailed reports are anticipated following the second (and final) year of the project.

GEOLOGICAL SETTING

The Sydney Synclinorium (Keppie, 1982) is bounded on the south by pre-Carboniferous rocks of the East Bay and Fourchu Blocks, and on the northwest by the Kellys Mountain Block. Both margins are major fault boundaries. The synclinorium comprises three major synclines with intervening arches, formed by pre-Carboniferous rocks of the Coxheath and Boisdale Hills (Fig. 2) . A pronounced northeasterly trend is noted for most major structures.

The structural configuration of the Sydney "Basin" was achieved in Viséan time or slightly earlier. Post-Carboniferous fault movements have accentuated the major boundaries, but at present probably limit a formerly more extensive basin of broadly similar configuration.

STRATIGRAPHY AND SEDIMENTOLOGY

General stratigraphic relationships of Carboniferous rock units within the 1982 map-area are schematically shown in Figure 3. Detailed descriptions of the major rock units and their subdivisions are not presented here. Aspects of the stratigraphy which are of significance include the following observations.

1. The Grantmire Formation at the base of the Carboniferous succession comprises alluvial fan deposits, mainly red conglomerate and sandstone. The Grantmire underlies, without apparent angular discordance, limestone similar in many aspects to the Gays River and Macumber Formations of southern mainland Nova Scotia (Giles and Boehner, 1979, Giles et al., 1979). Thus, the Grantmire underlies basal Windsor Group strata, and should not properly be assigned to the Windsor (cf. Bell and Goranson, 1938a, b and c).

2. The Windsor Group exhibits marginal facies near the base on the flanks of the Coxheath Hills where terrigenous rocks predominate. Marine intercalations represented by limestone and dolostone, are common in the middle and upper part of the Group. Minor showings of sphalerite and galena have been noted in the marine beds. Copper mineralization has been reported at the base of the Group at Frenchvale. Celestite also occurs in the Frenchvale area as cement in a lower Windsor sandstone bed.

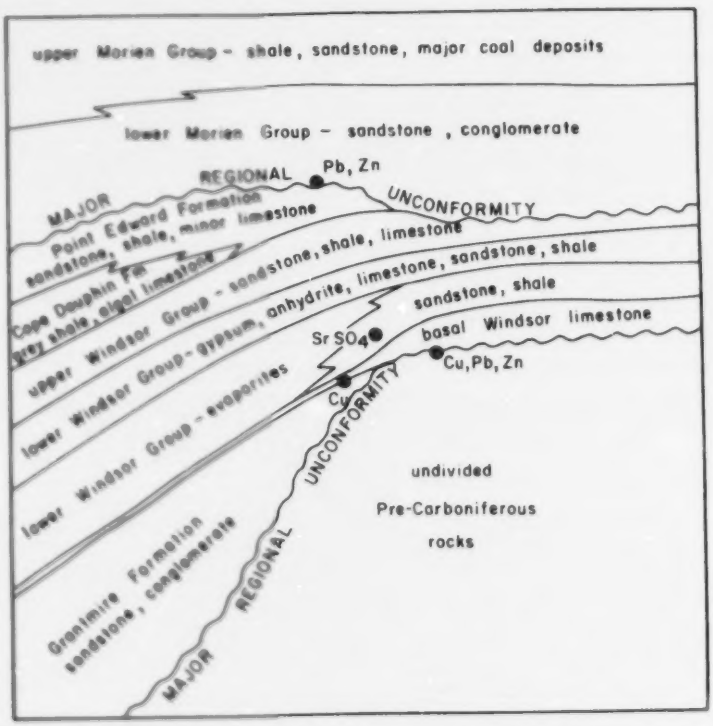


Figure 3. General stratigraphic relationships, Carboniferous succession of the Sydney Basin; vertical scale highly schematic, no horizontal scale implied.

3. The Point Edward Formation conformably overlies the Windsor Group, and comprises mainly red-brown sandstone and shale with occasional thin limestone beds of presumed fresh-water (lacustrine) origin. At some localities, grey shales with thin stromatolitic limestone intercalations rest conformably on the Windsor. This facies of the Point Edward Formation was termed the Cape Dauphin Formation by Bell and Goranson (1938b), but was reported from only the type locality.

4. Conglomerate and sandstone of the lower part of the Morien Group lie unconformably upon the Point Edward (or Cape Dauphin) Formation and may also be observed lying on Upper Windsor strata. Sedimentological studies suggest that the lower Morien was deposited in a braided stream environment as indicated by a general lack of fine grained overbank deposits. Paleocurrent data indicate that the major stream systems were controlled by the distribution of pre-Carboniferous arches bordering the major synclinal troughs. Upper Morien strata show more diverse paleocurrent patterns and are characterized by abundant overbank deposits with associated coal seams. Deposition from meandering stream systems is the probable origin for strata of the upper Morien.

5. In addition to major coal deposits, the Morien Group has been subjected to intensive exploration for lead and zinc, particularly in the Scotch Lake-Leitches Creek area near the apex of the Sydney Harbour Syncline.

STRUCTURAL HISTORY

Major fault movements post-date deposition of the Morien Group. Latest movements appear to have been mainly vertical. However, significant pre-Morien strike-slip movement can be argued for at least one major fault trending north-northeasterly in the vicinity of Georges River at the northeastern margin of the Boisdale Hills.

Large open folds are characteristic in the map area and affect all Carboniferous strata. Of interest is the "squared-off" nature of the major arches on the basinward extension of both the Coxheath and Boisdale Hills. These folds may owe their origin mainly to compaction over fault-bound suborthogonal pre-Carboniferous basement blocks. Basinward, the thicker sediment cover obscures the orthogonal pattern of folding.

SUMMARY

Carboniferous rocks of the Sydney Basin were deposited initially under conditions ranging from alluvial fan through lacustrine to marine environments. Later sedimentation was mainly in a fluviatile environment. The rocks are generally only weakly deformed. Mineralization is known, but is subordinate to nonmetallic industrial mineral potential (including coal) according to our present knowledge. The relevance of major fault movements and at least one major intra-Carboniferous unconformity to basin potential for base metals as well as possible hydrocarbon resources are yet to be fully assessed.

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1938b: Sydney sheet (East Half); Geological Survey of Canada, map 361a.

1938c: Bras d'Or sheet; Geological Survey of Canada, map 359a.

Giles, P. S. and Boehner, R. C.

1979: Windsor Group stratigraphy in the Shubenacadie and Musquodoboit Basins, central Nova Scotia; Nova Scotia Department of Mines and Energy, Open File Release 410, 1 map (1:100 000 scale), 19 Figures.

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LOCH LOMOND BASIN, WINDSOR GROUP PROJECT

R. C. Boehner

Field investigation and geological mapping of the Loch Lomond Basin (Fig. 1), first outlined by Boehner (1981), have been completed. Logging of a series of nine drillhole controlled cross-sections (approximately 6000 m) has been conducted in the area between Head of Loch Lomond and Big Glen-Terra Nova.

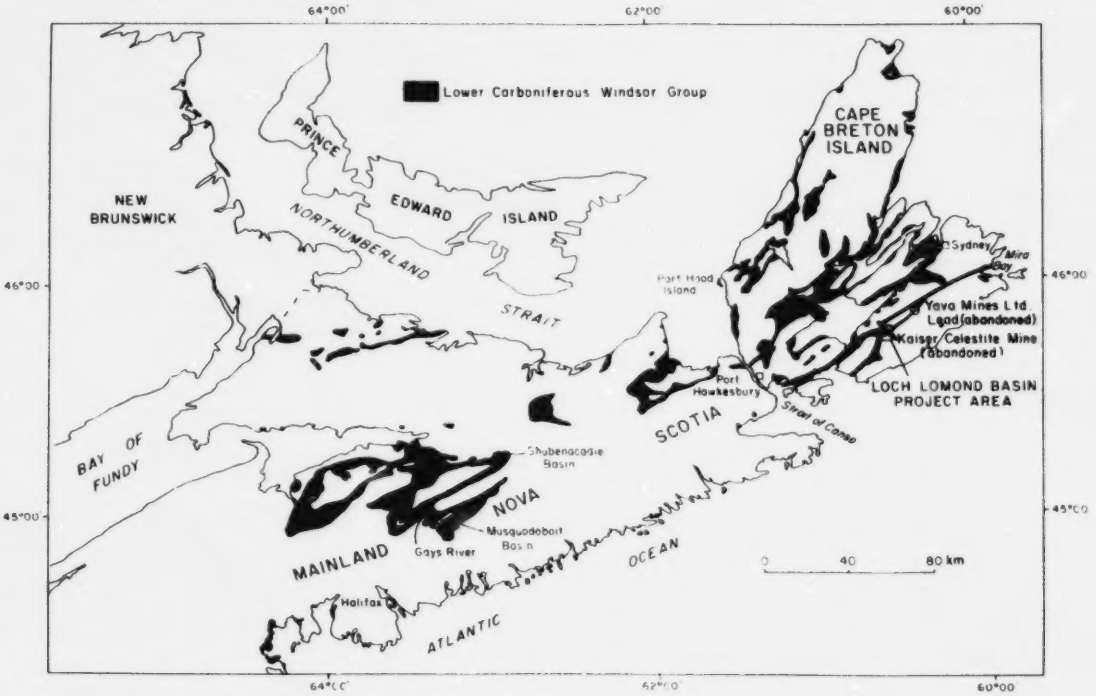

Figure 1. Location map, Loch Lomond project area.

Previously described Windsor Group onlap and Carboniferous overstep has been documented in detail (Fig. 2). The numerous mineral occurrences in the area are concluded to be closely related to paleogeography (topography), tectonics and sedimentation history (especially unconformities and stratigraphic onlap-overstep). Progressive onlap-overstep in a marginal molassic basin characterized by mixed continental alluvial and marine evaporite-carbonate deposition is inferred to be the principal factor which produced conditions suitable for the concentration and entrapping of celestite, barite, Pb, Zn, Cu, Mn and abundant, but economically unattractive Fe.

Stratigraphic pinchout of suitable host rocks, especially marine carbonates and carbonaceous sandstones, provided stratigraphic traps. Economic elements may have been carried in mineral-bearing formation water, generated from the degradation and diagenesis of clastic sediment in the basin. Environmental and hydrologic parameters ultimately controlled the local concentration of economic minerals.

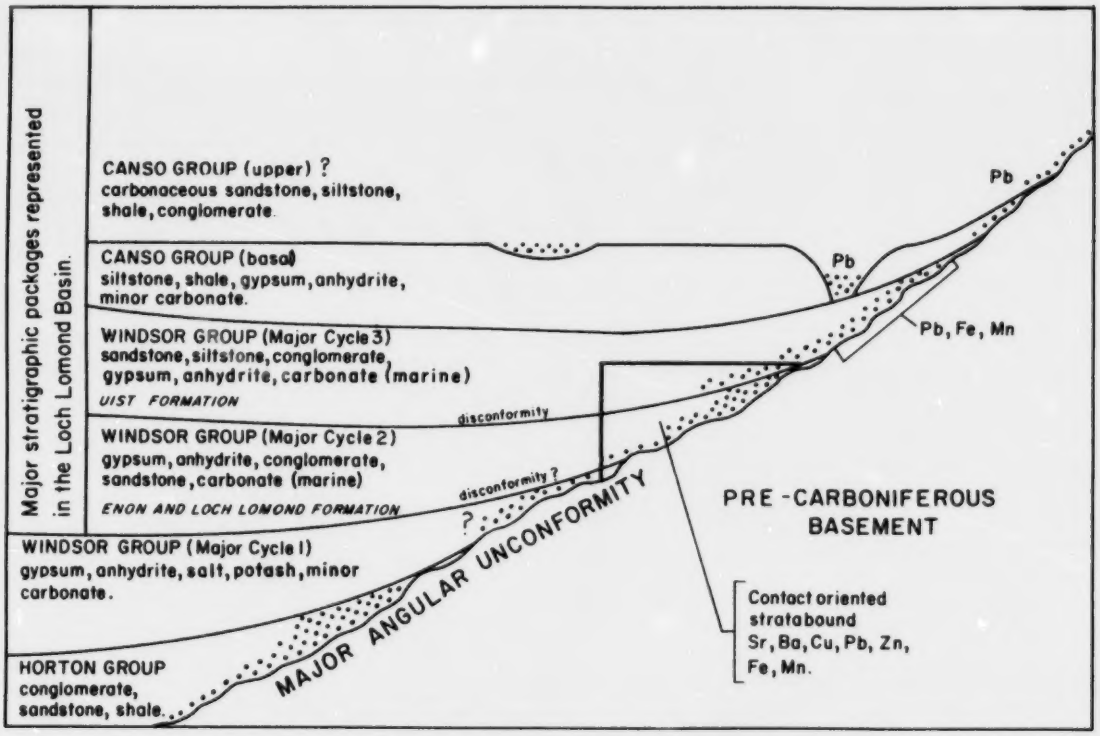
Major stratigraphic packages represented in the Loch Lomond Basin.
CANSO GROUP (upper) ?
carbonaceous sandstone, siltstone, shale, conglomerate.
CANSO GROUP (basal)
siltstone, shale, gypsum, anhydrite, minor carbonate.
WINDSOR GROUP (Major Cycle 3)
sandstone, siltstone, conglomerate, gypsum, anhydrite, carbonate (marine)
UIST FORMATION
disconformity
WINDSOR GROUP (Major Cycle 2)
gypsum, anhydrite, conglomerate, sandstone, carbonate (marine)
ENON AND LOCH LOMOND FORMATION
disconformity ?
WINDSOR GROUP (Major Cycle 1)
gypsum, anhydrite, salt, potash, minor carbonate.
HORTON GROUP
conglomerate, sandstone, shale.
MAJOR ANGULAR UNCONFORMITY
Pb
Pb
Pb, Fe, Mn
PRE-CARBONIFEROUS BASEMENT
Contact oriented stratabound Sr, Ba, Cu, Pb, Zn, Fe, Mn.

Figure 2. Schematic stratigraphy, onlap-overstep and mineral occurrences; Loch Lomond Basin and vicinity, Cape Breton Island.

Base metals ± minor celestite ± Fe, Mn occurrences are contact oriented and localized at or near unconformity pinchouts at all stratigraphic levels (Fig. 2). Secondary redistribution of celestite ± base metals ± Fe (supergene ?) is inferred to have occurred in karst related hydration zones. Barite and celestite ± Pb, Zn ± Fe are dominantly stratabound, stratified to nodular deposits (within marine carbonate, gypsum-anhydrite, red siltstone-sandstone) and may represent diagenetic replacement during or soon after Windsor Group sedimentation.

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SURFICIAL GEOLOGY OF THE WESTERN PART OF CUMBERLAND COUNTY, NOVA SCOTIA

R. R. Stea

ABSTRACT

Surficial materials of the western part of Cumberland County, Nova Scotia were mapped in the summer of 1982. New information was gained on the glacial history of the region. At Joggins, three tills were confirmed and studied in detail. An early eastward ice flow is indicated by 'old' striae and the lowest till at Joggins. Major south to southwest ice flows, created the upper two tills at Joggins and produced, upon recession, large areas of stratified drift including stagnation moraine and outwash deltas. Emerged marine features along the coast of Chignecto Bay decrease in elevation from 37 m at Squally Point to 15 m at Joggins. The oldest, eastward flow may be Early Wisconsinan in age; the later pulses of south to southwest-flowing ice, are probably Middle to Late Wisconsinan in age.

INTRODUCTION

Mapping of surficial deposits in northern Nova Scotia is part of a project which also involves trace-element analyses of till. This project is part of the Canada-Nova Scotia Cooperative Mineral Program 1981-4. It follows a program of surficial mapping and till geochemistry that was initiated by Canada Department of Regional Economic Expansion and the Nova Scotia Department of Mines in 1977 covering southern Nova Scotia on the Meguma terrane (Stea and Fowler, 1979; 1981; Stea, 1982; Stea and O'Reilly, 1982). The aim of this project is to provide a similar data base on the nature and extent of surficial materials and the effects of glaciation in order to aid mineral exploration, environmental assessment, and industrial construction.

The area covered by this report lies between latitudes 45°15'N and 45°50°N and the longitudes 64°20'W and 65°00'W, that is, west of Parrsboro. It is a summary of field work carried out during the 1982 season.

SURFICIAL UNITS

Glacially Scoured Bedrock

Areas along the Chignecto Bay coast of the study area are characterized by exposed bedrock with a discontinous veneer of till and boulders. The topography is controlled by bedrock with strike ridges formed by relatively resistant sandstone units. The till is generally thin (<1 m), loose, with clasts consisting primarily of the adjacent bedrock. The surface of many of the exposures was scoured by glaciers that moved generally southwestward. Pebbles in the sandstone matrix reveal 'pressure shadows' or miniature crag-and-tail. Many surfaces exhibit crossing striations with younger southwest-trending sets curving to conform to local topographic trends. Preserved on the lee side of some outcrops are relatively more weathered, more degraded striations that are oriented eastward and southeastward.

Regolith

The surface material of large areas in the Cobequid Highlands is bedrock that has been fragmented, disintegrated and altered to varying degrees in situ (Fig. 1). Mechanical and chemical weathering are implied. Hence, there is little or no evidence of glacial scouring in these regions.

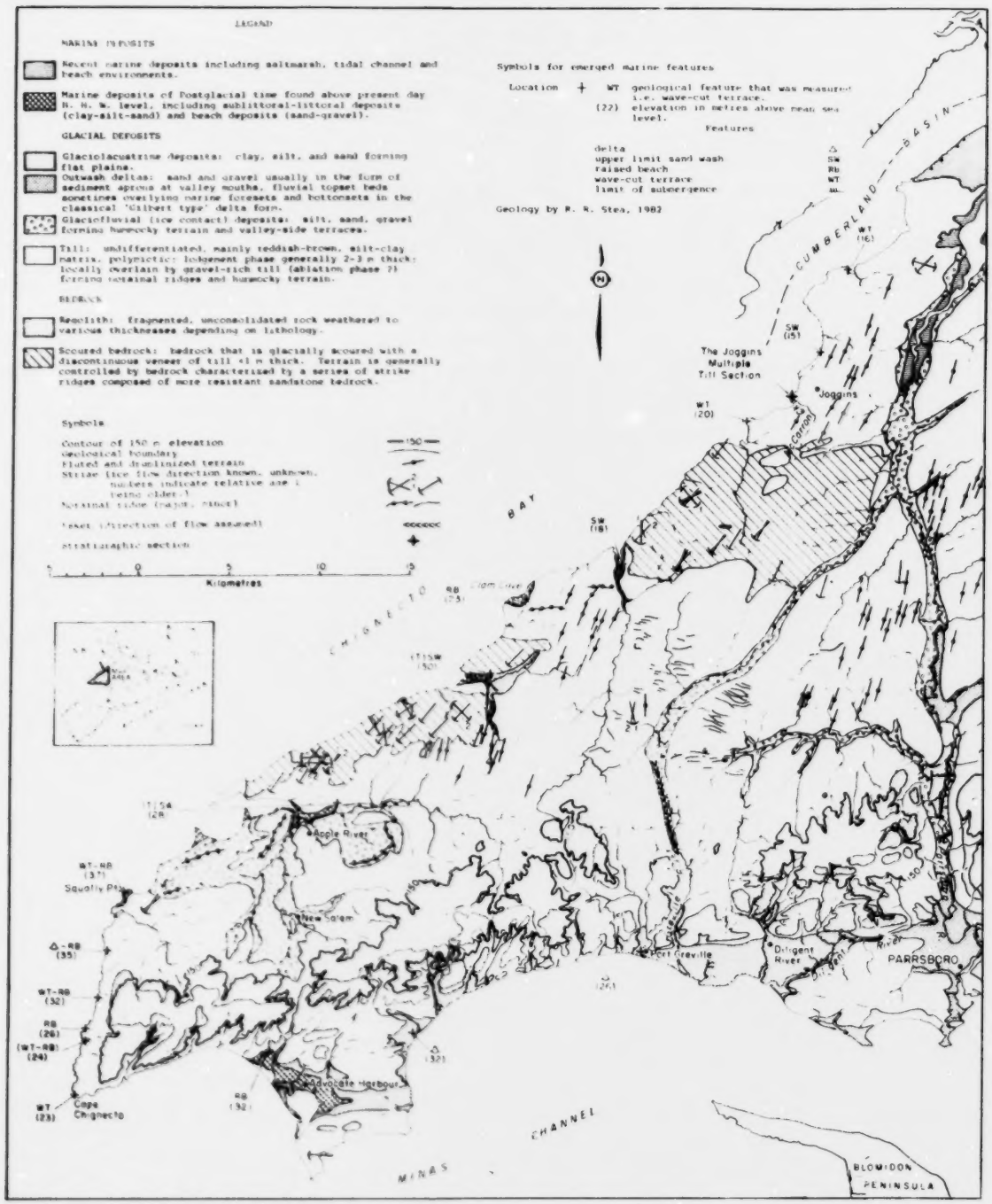
LEGEND
MARINE DEPOSITS
Recent marine deposits including saltmarsh, tidal channel and beach environments.
Marine deposits of Postglacial time found above present day M. H. W. level, including sublittoral-littoral deposits (clay-silt-sand) and beach deposits (sand-gravel).
GLACIAL DEPOSITS
Glaciolacustrine deposits: clay, silt, and sand forming flat plains.
Outwash deltas: sand and gravel usually in the form of sediment aprons at valley mouths, fluvial topset beds sometimes overlying marine foresets and bottomsets in the classical 'Gilbert type' delta form.
Glaciofluvial (ice contact) deposits: silt, sand, gravel forming hummocky terrain and valley-side terraces.
Till: undifferentiated, mainly reddish-brown, silt-clay matrix, polyictic: lodgement phase generally 2-3 m thick; locally overlain by gravel-rich till (ablation phase ?) forming retainal ridges and hummocky terrain.
BEDROCK
Regolith: fragmented, unconsolidated rock weathered to various thicknesses depending on lithology.
Scoured bedrock: bedrock that is glacially scoured with a discontinuous veneer of till <1 m thick. Terrain is generally controlled by bedrock characterized by a series of strike ridges composed of more resistant sandstone bedrock.
Symbols
Contour of 150 m elevation
Geological boundary
Fluted and drumlinized terrain
Striae (ice flow direction known, unknown, numbers indicate relative age (e.g. younger, older))
Terminal ridge (major, minor)
Esker (direction of flow assumed)
Stratigraphic section
Kilometres
Symbols for emerged marine features
Location + WT geological feature that was measured i.e. wave-cut terrace.
(22) elevation in metres above mean sea level.
Features
delta
upper limit sand wash SW
raised beach RB
wave-cut terrace WT
limit of submergence
Geology by R. N. Stea, 1982
CUMBERLAND BASIN
The Joggins Multiple Till Section
Joggins
Apple River
New Salem
Port Greville
Diligent River
PARRSBORO
Advocate Harbour
Cape Chignecto
CHIGNECTO BAY
MINAS CHANNEL
BLOMIDON PENINSULA

Figure 1. Surficial geology of the western part of Cumberland County.

Till generally pinches out up-slope against the friable rock and overlies it in some areas of the highlands. Bedrock lithology is evidently the controlling factor in the depth and intensity of rock weathering. Metamorphosed, steeply-dipping shales north of Advocate Harbour have been disrupted and disaggregated to depths of 10 m below the surface. Foliated granites at Cape Chignecto are only broken for 2-5 m. The age and genesis of this material is problematic, but it must predate the overlying till.

Till

The Joggins Till Section

At the mouth of McCarron Brook, north of Joggins, shore cliffs reveal 3 till units with a total thickness of 20 m. The section was first described by Wickenden (1941). Prest et al. (1972, p. 37) noted that from bottom to top the three tills are distinctly reddish, grey and yellowish and attributed them all to fluctuations of the southern and southwestern flowing ice. This author's observations on the section are summarized in Figure 2.

THE JOGGINS MULTIPLE TILL SECTION

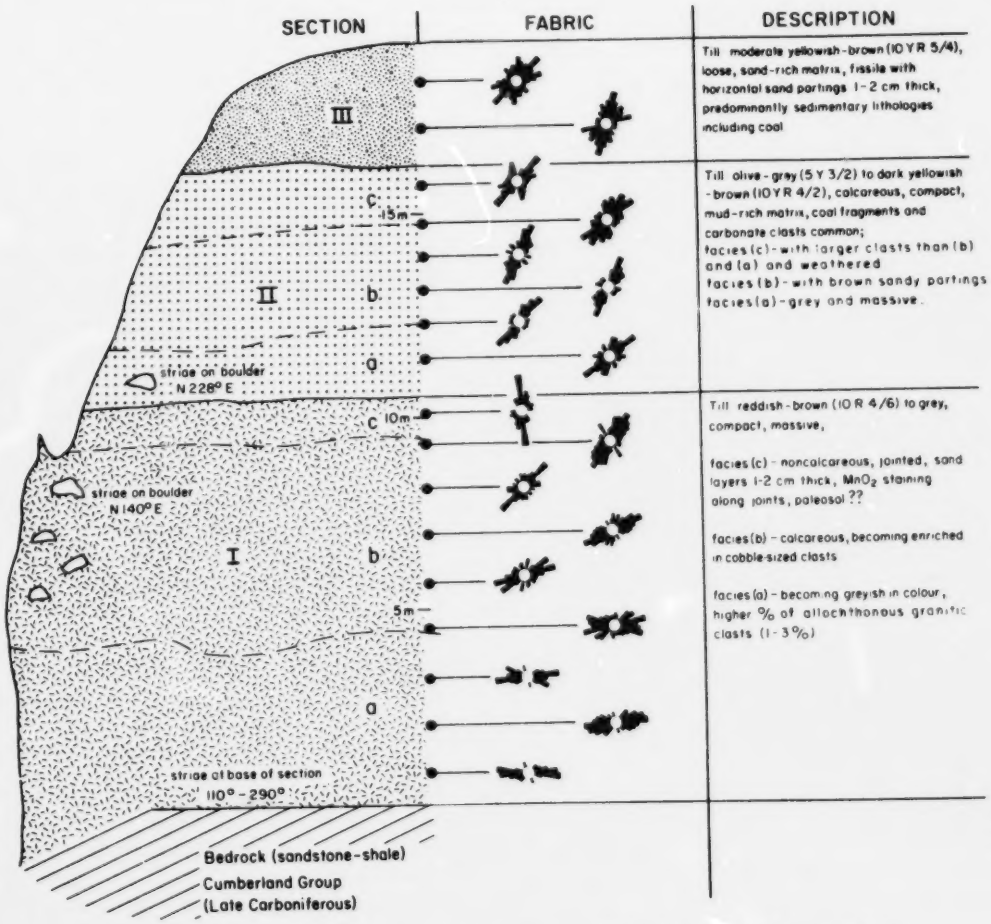
SECTION
FABRIC
DESCRIPTION
III
II
I
c
b
a
15m
10m
5m
striae on boulder N226°E
striae on boulder N140°E
striae at base of section 110° - 290°
Bedrock (sandstone-shale)
Cumberland Group
(Late Carboniferous)
Till moderate yellowish-brown (10 YR 5/4), loose, sand-rich matrix, fissile with horizontal sand partings 1-2 cm thick, predominantly sedimentary lithologies including coal
Till olive-grey (5 Y 3/2) to dark yellowish-brown (10 YR 4/2), calcareous, compact, mud-rich matrix, coal fragments and carbonate clasts common;
facies (c) - with larger clasts than (b) and (a) and weathered
facies (b) - with brown sandy partings
facies (a) - grey and massive.
Till reddish-brown (10 R 4/6) to grey, compact, massive,
facies (c) - noncalcareous, jointed, sand layers 1-2 cm thick, MnO_2 staining along joints, paleosol ??
facies (b) - calcareous, becoming enriched in cobble-sized clasts
facies (a) - becoming greyish in colour, higher % of allochthonous granitic clasts (1-3%)

Figure 2. Analysis of the Joggins multiple till section.

The lowest till (Unit I) is characterized by reddish hues and a higher percentage of allochthonous clasts, particularily chloritized, foliated granitic clasts. The provenance is uncertain, but is most likely to be New Brunswick. The fabric trends east-west at the bottom of the section and changes to almost north-south at the top. The till overlies a bedrock surface whose striae are oriented 110°-290° and are thus aligned with the till fabric. Unit Ic, below its contact with Unit II, shows signs of alteration. This may represent a period of subaerial weathering before deposition of the overlying till.

The upper tills (Units II and III) are characterized by a predominance of sedimentary clasts; mainly sandstone, limestone, and coal, and northeast-southwest striking fabric. Unit III is differentiated from Unit II by a weathered appearance and numerous sand partings along fissility planes.

Glaciofluvial Sediments

Ice-Contact Stratified Drift

Large bodies of ice contact stratified drift in the form of kames, kame terraces and eskers occur in the region; (Fig. 1) notably in the Apple River area, and in the valleys of River Hebert, Kelley and Parrsboro Rivers. Spectacular kame terraces are found along the Parrsboro River, associated with a recessional or end moraine (Wightman, 1980). These deposits show rapid changes in grain sizes between beds and in some cases have intercalated flow tills (Nielsen, 1976, p. 47). The deposits can reach up to 30 m in thickness.

The Apple River area is also characterized by ice contact deposits and moraines. D. R. Grant (personal communication, 1982) interprets this broad zone of ice frontal deposits to mark a major glacier marginal stand, perhaps the stadial limit.

Outwash and Outwash Deltas

South of the mouth of the Greville, Diligent and Parrsboro Rivers are flat plains, locally dissected, pitted, and terraced, composed of horizontal beds of gravelly sand. This unit has been termed the Saints Rest Member and is interpreted as outwash (Swift and Borns, 1967; Wightman, 1980). The Saints Rest Member is found, where shoreline exposure reveals stratigraphy, to overly marine foreset and bottomset beds termed the Advocate Harbour Member (Swift and Borns, 1967) in the classic 'Gilbert delta' form (Wightman, 1980).

Marine Sediments

Emerged Marine Features

At Advocate Harbour, the Saints Rest Member occurs inland from marine shoreline deposits (Swift and Borns, 1967). Raised strandlines occur in this area. The highest strandline west of Advocate Harbour was measured at 32 m above mean sea level. The outwash deltas and raised marine features along the southern coast are discussed in detail by

Wightman (1980). D. R. Grant (personal communication, 1982) notes that the kettled marine outwash terrace at Diligent River and the ice-contact scarps that back the terrace at the mouths of Wards Brook and Fox River to the west, point to a highly digitate ice mass confined to the valleys while the bulk of the marine terrace was constructed.

Along the coast from Cape Chignecto to Squally Point (Fig. 1) is a discontinuous wave-cut terrace in bedrock. At Squally Point this terrace has superimposed littoral-type deposits which attain an elevation of 37 m above mean sea level. The terrace elevation apparently decreases from Squally Point to Cape Chignecto (23 m above mean sea level), but it may actually be a complex of several successive levels.

Along the Chignecto Bay coast raised marine deposits are best exposed at Clam Cove where gullying along a logging road reveals a transition from unaltered till, a beach berm with rounded stones, to upper shoreface marine sands. The height of the emerged strandline is 23 m above mean sea level. The elevation of emerged marine features decreases along the coast of Chignecto Bay from an elevation of 37 m above mean sea level at Squally Point to 15 m at Joggins (Fig. 1).

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GEOCHEMICAL SURVEYS

P. J. Rogers

A stream sediment sampling survey was completed this summer for eastern Cape Breton Island. This joint project is part of the Canada - Nova Scotia Cooperative Mineral Program 1981-1984 and is funded through the Director General's office of the Geological Survey of Canada (GSC).

Approximately 1345 samples were collected from 4500 km^2 of Cape Breton Island; an average density of 1 per 3.4 km^2. The aim of this project is to complete within the next two years the stream sediment sampling cover for northern Nova Scotia. This marks the continuation and completion of work done between 1971 and 1978 (Fig. 1).

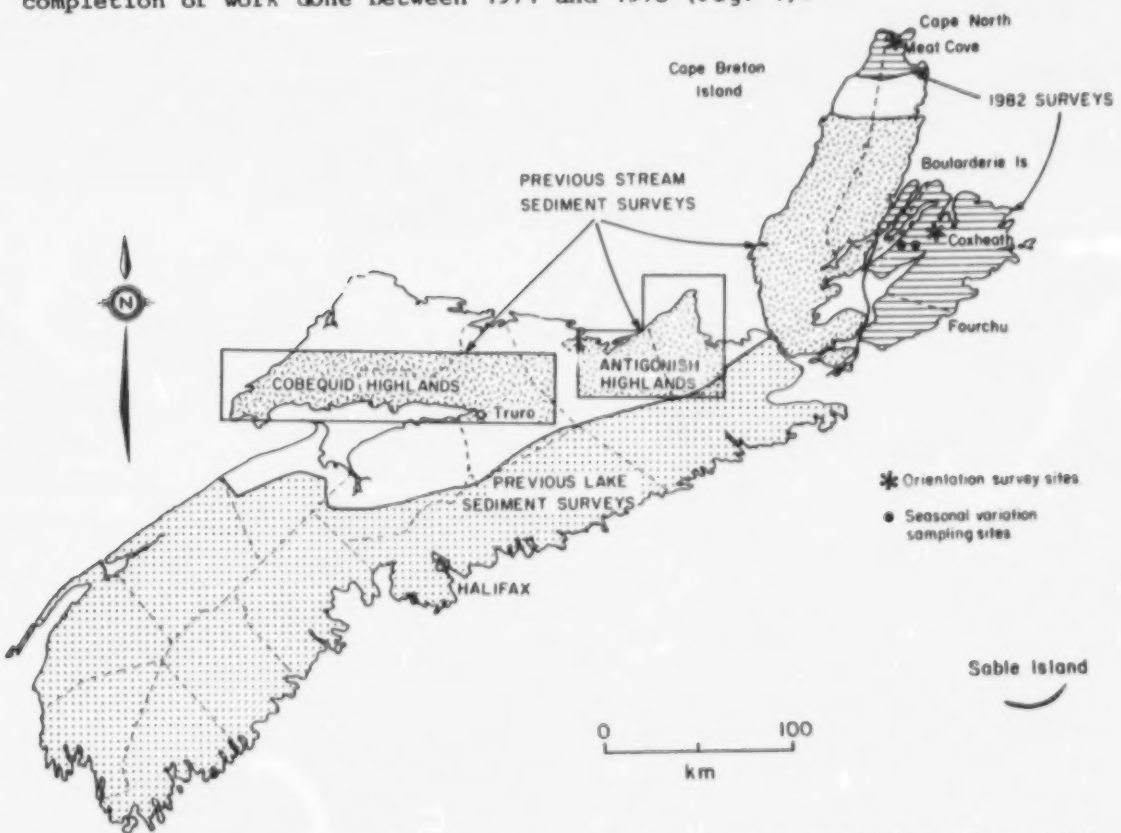

Figure 1. Extent of geochemical surveys coverage, Nova Scotia (post 1970).

In order to achieve this objective a much wider sampling grid was employed with a 2 km linear spacing between sample sites. All samples were wet-sieved onsite to pass through a 1 mm nylon screen. The sediment was collected in a plastic (gold) pan, placed in a paper envelope and an outer plastic bag for added security. Details of the sample site are recorded on standard GSC cards for subsequent computer coding and processing.

All of the samples will be analyzed for Cu, Pb, Zn, Ag, Co, Ni, Fe, Mn, Mo, Mg, U, and As. The levels and distribution of these elements within the secondary environment of Nova Scotia can then be plotted. The data obtained are useful for mineral exploration, environmental, health, and agriculture studies.

The varied bedrock geology and physiography within Cape Breton Island produces a number of terrane types, each with a different geochemical expression. For every geochemical sampling media and terrane type, a particular element will have a different value. In order to ascertain and quantify this a number of detailed geochemical orientation surveys have been and will be conducted throughout the survey area (Fig. 1). Statistical analysis of differing sample densities, spacings, size fractions, and analytical methods will yield data to assess the optimum values for the survey within Nova Scotia.

It is envisaged that the analytical values obtained will be published as uncoloured single element maps at a scale of 1:250 000. Colour composite maps at 1:1000 000 will be computer-produced to indicate the broader regional scale variation patterns for each element analyzed.

GEOLOGY AND GOLD DEPOSITS OF THE GOLDENVILLE FORMATION IN THE REGION BETWEEN SHERBROOKE AND SHEET HARBOUR

(N.T.S. areas 11D/16 and 11E/1)[1]

J. R. Henderson[2]

The structural geometry of the gold deposits in the Goldenville Formation was established by E. R. Faribault of the Geological Survey between 1882 and 1933. He demonstrated by detailed surface and underground mapping throughout the Meguma terrane the strong tendency for stratabound gold-bearing quartz veins to occur within slate beds on the hinge culminations of domical anticlines. The aim of our studies is to refine and extend the pioneer work of Faribault on the distribution and origin of gold in the Goldenville Formation in the region between Sherbrooke and Sheet Harbour.

Although the field work is only 40% complete, results to date show that 1) the metamorphic grade of Meguma Group pelites increases from biotite along the Atlantic coast to staurolite south of the West River St. Marys Fault, 2) biotite grade Meguma rocks show a component of finite east-west subhorizontal extension in a steeply-dipping flattening plane, 3) staurolite grade Meguma rocks exhibit a component of east-west dextral shear formed during intrusion of several concordant granites, 4) the largest granite in the region is discordant and post-kinematic, 5) solution and redeposition of quartz was a cleavage-forming process in Goldenville meta-greywacke during low grade metamorphism, 6) stratabound quartz veins have several distinctive geometries, textures and associated minerals which suggest a multiple genesis, 7) ground magnetic profiles taken across strike can be used to correlate meta-turbidites several metres thick between lines several kilometres apart.

We have mapped and sampled rocks and minerals from several localities in order 1) to determine average values for metal contents of all major rock types, 2) to assess the importance of arsenopyrite and pyrite as gold carriers, and 3) to evaluate the importance of bulk composition of slates on metal content. We have systematically sampled tills along strike and down-ice from several gold districts in order to map dispersal patterns of gold and other elements which may be useful to target new prospects. In October 1982 the Geological Survey flew a high resolution total magnetic field and vertical gradient survey of the area, and we anticipate using the data to complete the geological mapping during 1983.

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[1]Contribution to Canada-Nova Scotia Cooperative Mineral Program 1981-84. Project staffed and funded by Geological Survey of Canada.

[2]Geological Survey of Canada, Ottawa, Ontario

Paper 1

MEGUMA GOLD PROJECT
GEOLOGICAL HISTORY OF THE MEGUMA TERRANE IN THE COUNTRY HARBOUR AREA, GUYSBOROUGH COUNTY, NOVA SCOTIA

J. D. Keppie

This project is part of the Canada-Nova Scotia Cooperative Mineral Program 1981-4. It is a multidisciplinary study involving conceptual mapping of the area followed by various specialist studies. The area was selected on the basis of some recent mapping by McBride (1978) and Smith (1980) and problems identified during Province-wide surveys (Keppie, 1979, 1982; Chatterjee, in press). B. H. O'Brien and J. D. Keppie continued the mapping followed by detailed structural and metamorphic studies. G. K. Muecke has started a study of the metamorphic history and the phase chemistry of the metamorphic minerals. S. J. Haynes and P. K. Smith have been mainly involved with the metallogeny of the auriferous mineral occurrences in the area. J. W. F. Waldron has started a sedimentological study of the Goldenville Formation. R. D. Dallmeyer, A. N. Halliday and R. F. Cormier have begun geochronological studies in the area. B. Chevalier is doing a B.Sc. Honours thesis on the Bull Ridge pluton. The Geological Survey of Canada is undertaking an airborne gradiometer/VLF-EM (Hertz Industries BTRZ Totem 2A) survey of the area. All have contributed to varying degrees towards the various aspects of this project, however for the purposes of the Open House the various topics will be presented by different individuals under the headings outlined herein. Table 1 and Figure 1 have been prepared jointly and will be referred to in the Meguma Gold Project summaries.

The area is underlain by rocks of the Cambro-Ordovician Meguma Group divisible into the Goldenville Formation overlain by the Halifax Formation. The Goldenville Formation is mainly made up of sandy turbidites grading up and interbedded with thin slates and siltstones. The upper part of the Goldenville Formation is usually represented by a thin transition zone of thinly bedded sandstones and slates. The Halifax Formation is characterized by various types of slate (ferruginous, manganiferous, aluminous) in places green at its base, interbedding with thin siltstones and sandstones.

Deposition of the Meguma Group was followed by deformation, metamorphism and plutonism (Table 1). The earliest deformational event, D_s, is recorded by a foliation, S_s, defined by muscovite, biotite and possibly chlorite. It has a variable orientation relative to bedding and is associated with minor folds, F_s. Minor F_s folds are best preserved in the early quartz veins, which also exhibit a rodding lineation, L_s. They are rarely seen elsewhere in the Meguma Group. Mesoscopic F_s folds have been observed, but large scale structures have yet to be proven.

The major structures in the area are generally east-west, upright to asymmetrical, subhorizontal to gently plunging, cylindrical-noncylindrical-conical, F_g folds. Minor F_g folds were rarely observed except in the Halifax Formation. In the psammitic units a multistage development of pressure solution cleavage, S_g, during the D_g phase of deformation is inferred from such observations as intersecting cleavages of different orientations and cleavages mechanically rotated by F_g folds. In the

Table 1. Provisional geological history of the Meguma terrane in the Country Harbour area, Guysborough County, Nova Scotia (S. J. Haynes, J. D. Keppie, G. K. Muecke, B. H. O'Brien, P. K. Smith and J. W. H. Waldron).

Country Rocks			Veins			
*Deformation Event	*Structure	Associated Metamorphic Minerals	Relative Age	Polytype	**Gangue Minerals	**Ore Minerals
Late	Faults and joints Local cleavage Kink bands			ac joint infillings other veins	qz, kf, ch, sr, ca, qz	**aa, sx,** qz, py, po, cp, ?Au
D_M (?Hercynian) Mainly in the north	Crenulation cleavage Intersection and shape lineations Minor folds	mu				
D_M (?Hercynian) Mainly in the north	Crenulation cleavage, penetrative foliation Intersection and quartz rodding lineation Minor folds	mu, bi	Syn-D_M	Stringers Step veins	qz qz, bi, kf, pl, mu, an, gr, incl	aa ac, py, Au
			Syn-or pre-D_M	Stratiform	qz, kf, bi, at, to	aa, py, po, cp, Au
			pre-D_M	Strabound Stratabound lenscid	qz, bi, incl, kf, pl, at, to, ct, gr qz, incl, kf, bi, ct, mu, pl, at, an, to	aa, py, po, qz, cp, Au aa, py, po, cp, ac, Au
GRANITOID PLUTONISM (Assumption: that the Bull Ridge pluton is approximately the same age as the Sherbrooke pluton = 369 ± 2 Ma Rb/Sr whole rock isochron)						
STATIC METAMORPHISM		bi, ct, st, an				
D_C (?Acadian)	Crenulation cleavage Intersection lineation Minor folds and crenulations	ch, mu, bi	Syn- or pre-D_C	Quartz tension gashes in earlier carbonate-rich stratiform veins	qz	
D_Q (?Acadian)	Slaty cleavage Multistage pressure solution cleavage Intersection, shape and mineral lineation Major (and minor) folds	ch, mu, bi [local Mn-ct early D_Q or Syn-D_B]	Late Syn-D_Q	**Vertical veins** Radial veins in fold hinge	qz, kf, ch qz	
			Syn-to pre-D_Q	Concordant lenses in fold hinge Discordant veins in fold limbs	qz qz, incl, ch	aa
			Early Syn-to Pre-D_Q	**Step and side veins** Stratabound and side veins Stratiform and side veins	qz, kf, mu, ch, incl qz, incl, ch, sr, ca qz, incl, ch, ca sr	aa, py, po aa, py, po, qz, sp, Au aa, py, po, qz, sp, Au
D_B (?Acadian)	Cleavage Quartz rodding lineation Mesoscopic folds	ch, mu, bi	**Step and side veins** Pre-or Syn-D_B	Stratabound and side veins Stratiform and side veins	qz, kf, mu, ch, incl qz, incl, ch, ca, sr qz, incl, ch, cr, ca	aa, py, po aa, py, po, qz, sp, Au aa, py, po, qz, sp, Au
CAMBRO-ORDOVICIAN SEDIMENTATION OF THE MEGUMA GROUP: Halifax and Goldenville Formations Goldenville Formation: (i) Diagenesis - redistribution of carbonate into concretion layers - reworking by dewatering and bottom currents (ii) Depositional systems - proximal turbidites deposited in channels by west to east currents - associated "distal" facies represents interchannel deposition (iii) Sources - supermature poly-quartz, quartz and sedimentary rock fragments - poorly sorted detrital qz, kf, pl, mu, py, to, sr, an, clay matrix						

* Deformation events and structural fabric elements are named after type localities and abbreviated as follows:
D_M - Melrose; D_W - Waterrush; D_C - Country Harbour; D_Q - Guysborough; D_B - Sherbrooke

Bold abbreviation indicates essential constituent
Bold type in vein polytype indicates crosscutting relationship

**Abbreviations:

an:	andalusite	bi:	biotite	ga:	galena	Kf:	K-feldspar	sc:	scheelite	st:	staurolite
as:	arsenopyrite	ca:	carbonate	gr:	graphite	mu:	muscovite	sn:	sphene	sx:	specularite
at:	actinolite	ch:	chlorite	gt:	garnet	po:	pyrrhotite	sp:	sphalerite	to:	tourmaline
Au:	gold	cp:	chalcopyrite	incl:	inclusions	py:	pyrite	sr:	sericite	zr:	zircon

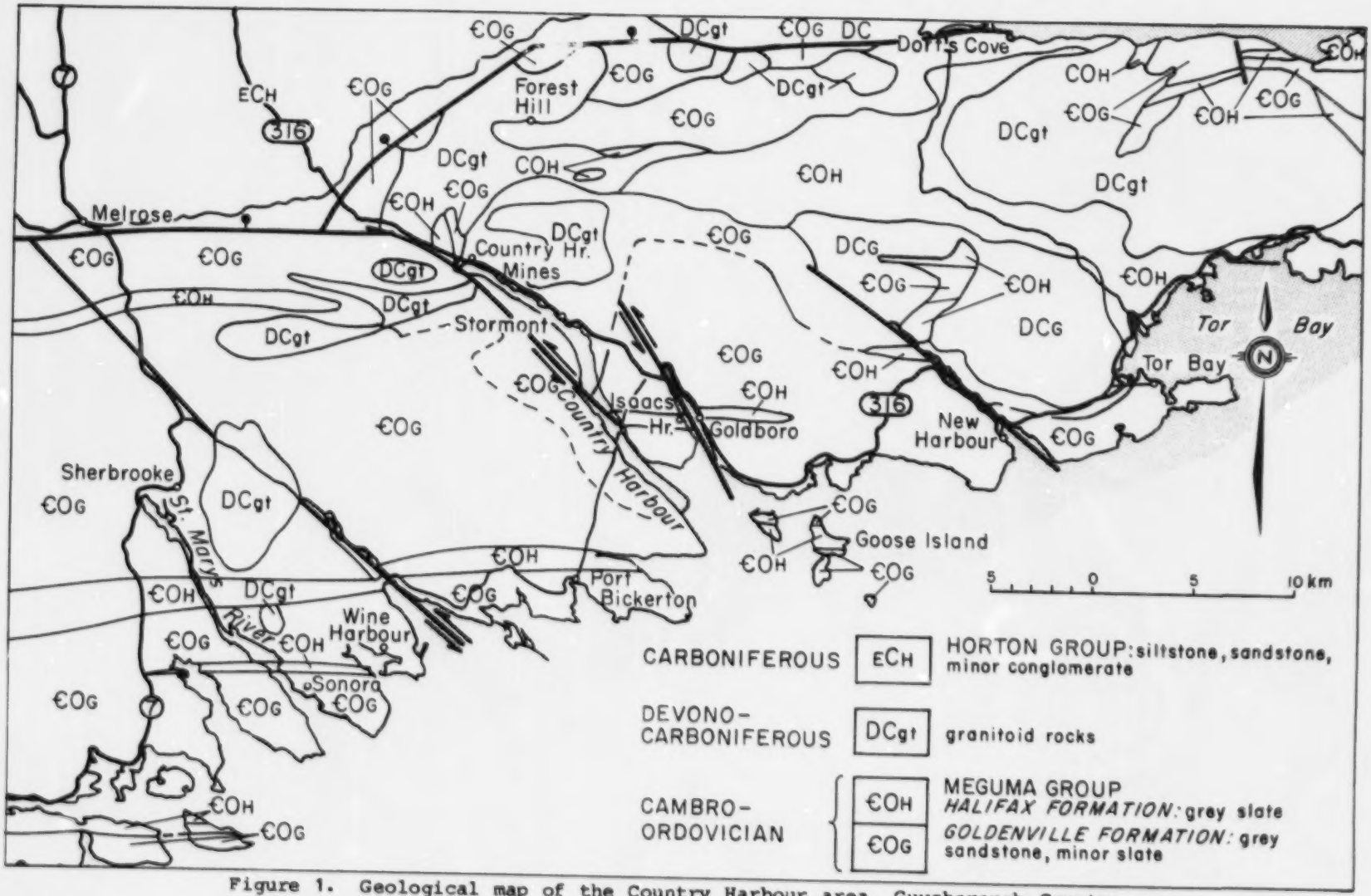

Figure 1. Geological map of the Country Harbour area, Guysborough County, Nova Scotia (modified from Keppie, 1979).

pelitic units, a slaty cleavage developed during D_g. Lineations L_g, associated with this phase of deformation include intersection, shape and mineral lineations, and the long axes of sand volcanoes, all of which are approximately parallel to F_g fold axes. A greenschist facies metamorphism associated with D_g is indicated by the growth of chlorite, muscovite and biotite in the S_g foliations.

The succeeding D_c phase of deformation is recorded by the sporadic development of recumbent F_c folds and crenulations associated with a crenulation cleavage, S_c, defined by muscovite, biotite and possibly chlorite.

These events were followed by a regional static low pressure metamorphism which increases in grade from chlorite in the southwest through biotite and garnet to andalusite and staurolite in the northeast. Although the Sherbrooke granitoid pluton is roughly coincident with a local metamorphic high, in detail its northern margin truncates the garnet and staurolite isograds (Smith, 1980). This pluton has yielded a whole rock Rb/Sr isochron of 369 ± 2 Ma thereby providing a latest Devonian upper limit on the preceeding events. The widespread granitoid plutonism in the eastern end of the Meguma terrane coincident with the area of high grade metamorphism suggests that the regional metamorphism and plutonism are temporally related.

In the northern third of the area, many of the plutonic rocks exhibit one or two foliations, and in the country rocks foliations defined by mica wrap around presumed static porphyroblasts. In a preliminary working model, it is assumed that one of these deformed plutons, the Bull Ridge pluton is approximately the same age as the Sherbrooke pluton. From this, it follows that the deformation within it and the surrounding host rocks is later. These phases of deformation are designated D_W and D_M. The D_W phase is expressed as an east-northeast to west-southwest steeply dipping crenulation cleavage or penetrative foliation S_W, and intersection and shape lineations L_W, attendant to minor folds F_W. Kinematic interpretation of these fabrics suggests a subhorizontal dextral sense of shear. The succeeding D_M phase of deformation includes an east-west steeply dipping crenulation cleavage S_M, and intersection and shape lineations L_M attendant to minor folds F_M. It is also attributed to subhorizontal, dextral shear deformation. The S_W and S_M foliations are best developed in shear zones which in the south are widely spaced where they generally affect the more pelitic units, whereas they are pervasive in the north. Metamorphism associated with these fabrics appears to be limited to the greenschist facies. Locally, the growth of muscovite appears to postdate these fabrics.

These events are followed by the development of local crenulation cleavage, kink bands, faults, joints and crosscutting veins of various orientations.

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A STRUCTURAL CLASSIFICATION OF QUARTZ VEINS IN GREENSCHIST FACIES ROCKS, MEGUMA GROUP, EASTERN NOVA SCOTIA

B. H. O'Brien

Attempts to classify veins of predominantly quartz in the gold camps of eastern Nova Scotia began with the local, nongeological, descriptive terms of the miners themselves. Veins have been distinguished relative to each other by their crosscutting relationships, their alteration products and their silicate and sulphide mineralogy (e.g. see Haynes, this volume; Smith, this volume). The tectonic features displayed by the quartz veins in the Meguma Group form the basis for a structural classification which is comparable to those based on vein morphology and composition (Table 1). In this presentation some of the tectonic structures that affect the quartz veins are illustrated and suggestions are made on how vein arrays can be differentiated using the structures they exhibit.

In the chlorite and biotite zones of regional metamorphism quartz veins are most readily separated by their relationships to the ubiquitous slaty and pressure solution cleavages (S_g in Table 1). Two groups of veins can be easily distinguished in the field. An early array is commonly transected by steep S_g cleavage; a late array is injected along joints or faults that displace or distort S_g.

Veins belonging to the early array are in part auriferous, have been emplaced before and during several structurally-dated episodes of metamorphism and appear to be unrelated to post-D_c veins of granite and pegmatite (Table 1). The exact relations of the early vein array to the developing F_s and F_g folds is not firmly established. However, it is typical of all pre-S_g quartz veins to illustrate folds, although the shape and orientation of such folds is highly variable. Furthermore, some folded veins are deformed along with bedding (i.e. saddle reefs), while others fold independently of this surface. Pre- or syn-D_s veins (Table 1) exemplify the former type. In places these veins lie parallel to bedding and together with bedding are folded about F_s minor folds to which S_s cleavage is axial planar (Fig. 2a). The once recumbent F_s folds are refolded by minor F_g folds and corrugations themselves traversed by upright S_g cleavage. The relations of one particular quartz vein folded independently of bedding are illustrated in Figure 2b. Here a small train of minor, gently plunging, F_g isoclinal folds are cleaved axial planar by upright S_g slaty cleavage. Pre-S_g step veins cross the vertical beds and outline open to close, gently plunging F_g minor folds. From Figure 2a and 2b it is evident that quartz veins have been emplaced over a considerable period of time and, moreover, that they record various increments of the total D_s and D_g strain.

Important data are provided by folds that are defined by veins, but not by the beds they intruded. For example, some step veins were emplaced after bedding was already steepened either by F_s or F_g folding. Subsequent pre-S_g slip along bedding planes does not produce parasitic folds of the bedding; rather an associated shortening is witnessed by other planes in the field of buckling at this time, e.g. the step veins and the S_s cleavage. In some localities folded side veins contain relict fibres of quartz perpendicular to the vein wall. These fibres are folded

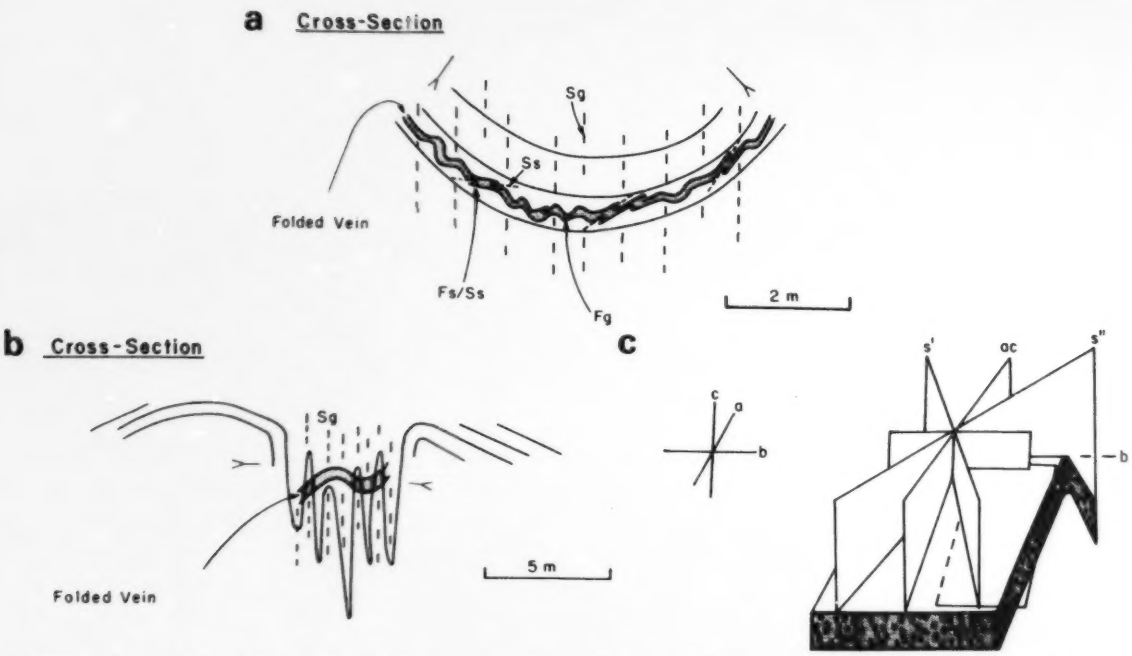

Figure 2. Sketches depicting some tectonic features of the Meguma Group in the western part of Guysborough County (a) the relations of folded veins to S_s and S_g cleavage and F_s and F_g folds (b) the relations of folded veins to minor F_g isoclinal folds and axial planar S_g slaty cleavage (c) the relative orientations of ac-joints, bc-joints, steep conjugate shear joints (s' and s") and flat conjugate shear joints.

passively around F_g minor folds indicating that probably planar, vein-filled, extensional fractures were later compressed. Some small side veins appear to have formed in propagating fractures that developed during the folding of stratabound veins. Such vein-filled fractures have a number of different orientations relative to the F_g axial surface. Independent evidence of this comes from the fold plunge of pre-S_g veins which varies from horizontal to reclined. It follows then, that at any particular instance, certain veins in the early array are more prone to be folded than others and that fold amplitude and wavelength are not in themselves indicative of the relative time of emplacement. Some pre-S_g veins are folded and boudinaged in late D_g and succeeding deformations.

The late array of veins is injected along joints, fault gouges and kink planes. With reference to the major, east-west trending F_g fold axes, these veins occupy: (a) N-S, subvertical ac-joints (b) E-W subvertical bc-joints (c) NE-SW and NW-SE, steeply dipping, conjugate shear joints, and (d) E-W, gently dipping, conjugate shear joints (Fig. 2c). Displacements along certain joint surfaces overlapped others. This occurred when siliceous fluids were still in transport as well as after the

solidification of the veins. Within the late vein array quartz crystallized under conditions of nonhydrostatic and hydrostatic stress; the former producing fibrous and the latter massive or vuggy textures. The orientation of fibres relative to the vein walls, the subsequent rotation of these fibres and the attitude of slickensides on vein quartz together suggest that shear movements were largely horizontal or possibly oblique slip on the ac-, bc- and steep shear joints.

RELATION OF GOLD TO QUARTZ-VEIN POLYTYPES IN GREENSCHIST FACIES TURBIDITES, MEGUMA GROUP, EASTERN NOVA SCOTIA

S. J. Haynes

Field studies of the historic Meguma Group gold districts at Wine Harbour (chlorite zone) and Isaac's Harbour-Goldboro-Seal Harbour (biotite zone) have revealed the existence of at least eleven different quartz vein polytypes. Although specific mineralogies may vary between individual veins of a polytype, each polytype displays characteristic mineral associations which appear to be independent of the grade of greenschist facies metamorphism.

The quartz veins are located in "Bouma-like" meta-greywacke to slate sequences of the Goldenville Formation. Carbonaceous horizons, manganiferous lenses and lensoid pyrrhotiferous pods are present in the psammitic units. Locally, augened pseudo-porphyroblasts of arsenopyrite are abundant in the slates and semi-pelites, sometimes associated with other sulphides. At the Victoria Lead, crenulated wisps of gold are disseminated in slate.

The polytypes are distinguished on the basis of their form, characteristic mineralogy, wall-rock alteration, and crosscutting relationships to each other and regional structures:

1. **Stratiform veins (± Au)** are ribbon veins comprising alternating layers of quartz and host rock (and often carbonate) conformable to bedding. Usually, F_g corrugations are present. At Isaac's Harbour these veins also display L_s quartz rodding and possibly F_s minor folding. Gold, arsenopyrite, pyrite, pyrrhotite, galena, sphalerite, chacopyrite and specularite have been observed. Bilateral arsenopyrite-sericite-tourmaline wall-rock alteration, only apparent at chlorite grade, envelopes some of these veins.

2. **Stratabound veins (± Au)** are boudinaged quartz veins with irregular, chloritized, bands of host-rock inclusions. They are resticted to slate horizons, but locally crosscut bedding. Thin varieties are only weakly boudinaged. They display similar ore mineralogy and wall rock alteration to the stratiform type.

3. **Step veins (No Au)** are discordant veins cutting psammites at high angles, and slates at low angles, in a series of folded steps traversing bedding. Within slates, they are boundinaged and contain masses of K-feldspar and muscovite, and chloritized inclusions of sulphide-bearing host rock. At chlorite grade, bilateral arsenopyrite+ sericite wall-rock alteration is well developed. Although these veins generally cut through statiform and stratabound polytypes, one step vein melds with a stratiform vein at Isaac's Harbour. This suggests that the step veins acted as feeders. They are cut by S_g cleavages.

4. **Side veins (No Au)** are tightly-folded veins tapering away from T-junctions with stratiform, stratabound and step veins. They display similar mineralogy and alteration to their "parent" vein. Quartz fibres, normal to vein walls are often present. They exhibit wide variation in attitude to their parent vein, but are cut by S_g cleavages.

5. **Discordant lenses (No Au)** are F_g folded 'tension' gashes within psammites (Wine Harbour), or slates (Indian Harbour). Varieties in slates are boudinaged and contain host-rock inclusions. They are cut by S_g cleavages.

6. **Concordant lenses (No Au)** are small quartz lenses, conformable to bedded psammites, folded around F_g fold hinges. The relation to S_g cleavage is unclear.

7. **Radial veins (No Au)** are tension veins, in the outer arc of psammite beds, radiating around tight fold hinges.

8. **Vertical veins (No Au)** are weakly-deformed quartz-chlorite-K-feldspar veins that cut polytypes 1 to 7. They are crenulated by S_g cleavages.

9. **Quartz tension gashes (No Au)** are tension infillings of carbonate-rich stratiform veins.

10. **Late quartz veins (No Au)** are quartz infillings of late joints and kinks of various orientations that warp S_g cleavages.

11. **ac-joint infillings (±Au?)** are northerly-trending quartz K-feldspar-sericite-chlorite-arsenopyrite-specularite veins which warp S_g cleavages. A variety of other sulphides may be present. Intense sericitic wall-rock alteration is characteristic. Gold may be present.

The association of auriferous stratiform and stratabound veins with sericite-tourmaline wall-rock alteration and K-feldspar + muscovite bearing step vein "feeders" indicates that the gold was deposited from (or mobilized by) hot hydrothermal solutions. Derivation of these solutions from the granitoids in the area is unlikely because plutonism postdated S_g cleavage. Also, metamorphogenic solutions related to the major period of deformation (D_g) are not good candidates for gold transport because pressure solution cleavage (S_g) postdates the gold veins. Many gold districts are preferentially located near the hinge zones of asymmetric, step-form, F_g folds rather than the upright, essentially concentric, F_g folds. The presence of disseminated sulphides and gold in the host rocks, the type of fold geometry and the "feeder-like" relationship of a cross-cutting step vein to a stratiform ribbon vein is suggestive of a submarine hydrothermal-vent system with attendant seafloor chemical sedimentation (stratiform veins), intrasediment sills (stratabound veins and some stratiform veins) and fault-controlled feeders (step veins). Hydrothermal processes related to D_s events (O'Brien, this volume) cannot be discounted and may have mobilized gold. D_s and D_g events resulted in the formation of the discordant lenses, folded lenses, folded tension gashes, radial veins and the vertical veins, but none of these contain gold. However, any D_s or D_g model has to explain the physico-chemical environments in which the radically differing mineralogies of the stratiform and step veins were precipitated.

The origin of the late veins and metal-rich ac-joint infillings is, as yet, unknown but may be related to the major northwest-southeast trending regional fault systems and/or granitoid plutonism.

GENERAL GEOLOGY OF THE COCHRANE HILL GOLD DEPOSIT WITH A CLUE TO RELATIVE AGES OF GOLD GENERATION

P. K. Smith

INTRODUCTION

Gold deposits in Nova Scotia are predominantly confined to the Meguma terrane underlying the southern part of the Province. Because deposits are located in both greenschist facies and amphibolite facies rocks it is critical to compare and contrast deposits from each metamorphic grade.

The following general geological description of the Cochrane Hill deposit in southeastern Nova Scotia shows evidence suggesting multi-stage gold and quartz vein generation relative to the static amphibolite grade metamorphism.

LITHOLOGY

The varied lithologies around the Cochrane Hill area cannot unequivocally be put in their correct stratigraphic position due to the complex structure. However, rock types occurring within the mine pit are described in their present position from north to south as follows (no stratigraphic or structural order implied and thicknesses are averaged):

a) graphitic schist with abundant calc-silicates and finely disseminated sulphides (≈5 m thick).
b) manganese calc-silicate bearing psammite with abundant vein development and arsenopyrite mineralization (≈10 m thick) * Au bearing.
c) cherty or silica-rich psammite with calc-silicate and high quartz vein content (≈ 5 m thick) * Au bearing.
d) staurolite pelitic schist with almost no quartz vein development (≈ 7 m thick).
e) psammite with calc-silicate and interbedded pelitic schist containing numerous quartz veins and several graphite shear zones parallel to bedding; locally massive sulphide in veins along northern side (≈ 15 m thick) * Au bearing.
f) fragmental shear zone bounded by thin graphitic shears (≈ 1 m thick).
g) psammite with calc-silicate and interbedded pelitic schist containing numerous quartz veins (≈ 3 m thick) * Au bearing.
h) arsenopyrite-rich pelitic schist with very minor quartz vein development (≈ 4 m thick) * Au bearing.
i) psammite with calc-silicate and interbedded pelitic schist containing numerous quartz veins, locally late cross shear fractures are common (≈ 7 m thick) * Au bearing.
j) calc-silicate bearing staurolite-rich pelitic schist interbedded with more psammitic zones; quartz veining is not prominant (>10 m).

METAMORPHISM

Amphibolite grade of regional static early metamorphism occurs at Cochrane Hill. The porphyroblastic mineral assemblage includes muscovite, biotite, garnet, staurolite, and andalusite. These minerals contain inclusion trails and are observed to be augened by at least two later foliations (D_W and D_M) defined by muscovite-biotite and muscovite respectively. The relationship of the porphyroblasts and an earlier fabric ($?D_C$) has yet to be established.

STRUCTURE

The oldest recognized fabric at Cochrane Hill is a chlorite, muscovite, biotite foliation trending prominantly east-west and dipping generally steeply towards the south. Its age relative to the static metamorphism is uncertain. For the present purpose it is simply correlated with either D_S, D_g or D_C (Table 1) from the southern terrane and is therefore not further elaborated upon.

Two later fabrics in the mine area both postdating the static metamorphism are defined as D_W and D_M (Table 1) structural elements.

D_W is the most pervasive trending east-west and dipping steeply to moderately northward. It is characterized by a muscovite-biotite foliation and has a westward shallow plunging intersection lineation on the bedding surfaces. Associated minor folds are locally observed.

D_M is a slaty crenulation cleavage defined by muscovite and trending subparallel to bedding which is east-west and dipping steeply towards the north. The intersection lineation on the bedding plunges steeply to shallowly westward. Minor folds are observed only in crosscutting quartz veins.

ECONOMIC GEOLOGY

Visible gold within the confines of the mine area is generally restricted to quartz veins or to the wall rock immediately adjacent to the veins although it is also found as dissiminated blebs attached to and within arsenopyrite and garnet porphyroblasts as well as in pelitic schist of subdividion "h" described earlier. The following observations indicate that the gold is of several ages: 1) garnet porphyroblasts overprinting gold suggests gold existed prior to static metamorphism (Fig. 3) and 2) gold in veins which crosscut similar garnet porphyroblasts suggests some gold postdates static metamorphism (Fig. 4). Smearing of gold into thin leafs along late shear fractures is locally common in subdivision "i" lithology.

The age, type and mineralogy of veins in the Cochrane Hill mine area are complex and only briefly described in Table 1. Suffice it to say that some veins and gold predate the amphibolite facies static metamorphism and may be as old or older than the first structures recognized in the south (see O'Brien, this publication) and some veins and associated gold are later than the same static metamorphism.

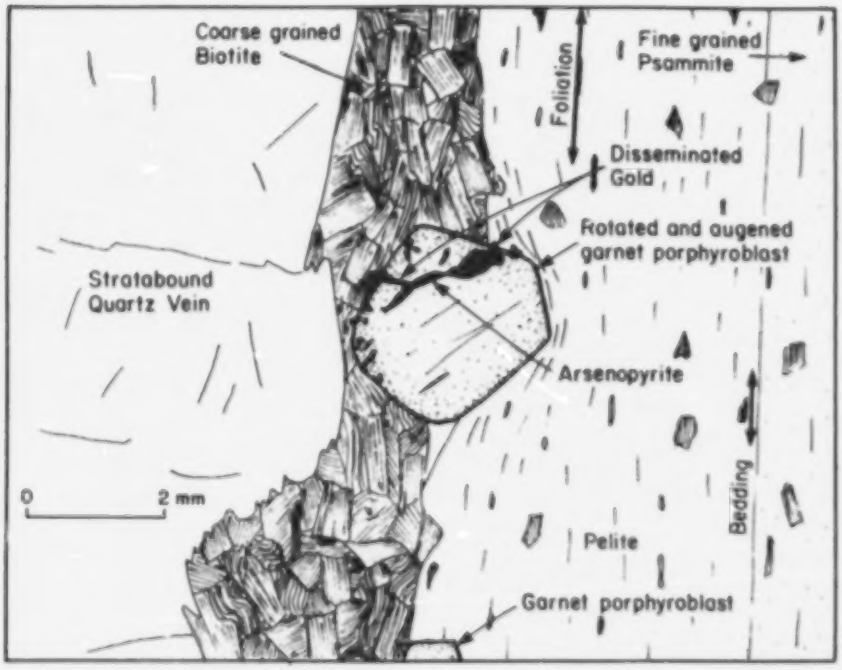

Figure 3. Rotated and augened garnet porphyroblast associated with coarse grained biotite adjacent to stratabound quartz vein. Note the overprinting of earlier or contemporaneous gold and arsenopyrite by garnet.

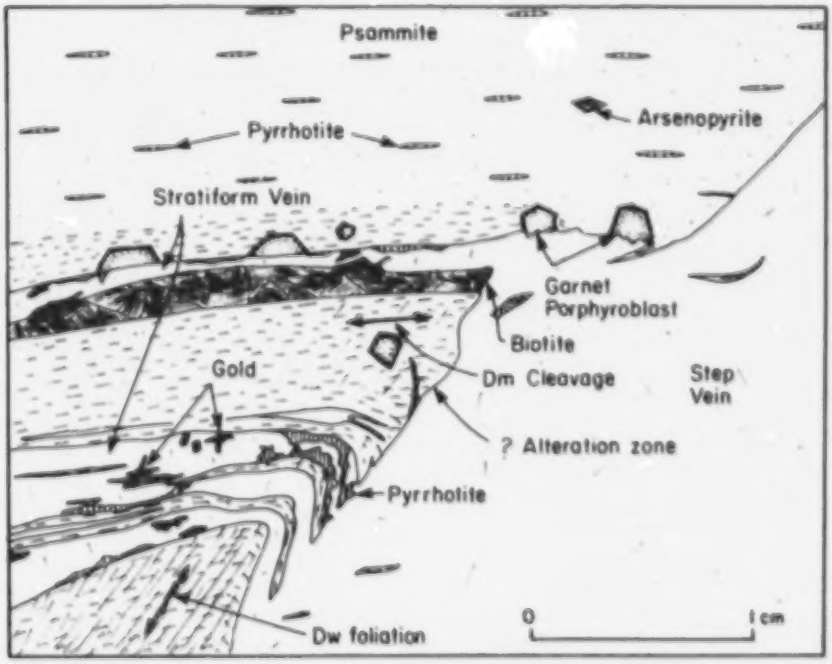

Figure 4. Garnet porphyroblasts cut by stratiform auriferous quartz veins in turn crosscut by a later step vein. Note the apparent alteration associated with the stratiform vein.

SEDIMENTARTY FEATURES OF THE GOLDENVILLE FORMATION, SHERBROOKE AREA, NOVA SCOTIA

J. W. F. Waldron[1]

The Goldenville Formation in eastern Nova Scotia resembles other Lower Paleozoic greywacke terranes in consisting of monotonous alternations of sandstone and slate, which have so far resisted attempts at stratigraphic subdivision. Several unique features indicate peculiarities of both the depositional environment and the source area.

Goldenville sandstone beds range from less than 1 cm to several metres in thickness. They commonly show sharp scoured basal surfaces against underlying slate, with abundant grooves and flutes. Top surfaces of sandstone beds may be gradational or sharp. Depositional sedimentary structures within beds include parallel and ripple crosslamination, and locally abundant slate intraclasts. Synsedimentary deformation and water-escape produced convolute lamination, load casts and pseudonodules, dish, pipe and sheet structures, and abundant small sand volcanoes. Sandstone dykes penetrate upwards into overlying slate at some horizons.

Sandstone beds may be classified into two groups according to the nature of the top surfaces. **Beds with gradational tops** correspond well with those described from submarine fan environments elsewhere (Walker, 1979). Three intergradational types are recognized (Fig. 5).

1) **Massive sandstones** are typically 50 cm to 3 m thick, but frequently occur in amalgamated packets, within which distinct depositional events are difficult to distinguish. Grading is usually confined to the top few centimetres, in which parallel or ripple crosslamination may be present.

2) **Proximal turbidites** are usually 10 cm to 50 cm thick, and grade into overlying slates. They show complete (T_{abcde}) or partial (T_{abe} or T_{ae}) Bouma sequences.

3) **Distal turbidites** are generally thinner and lack the basal structureless "a" division of the Bouma sequence. Thinner beds lack the "b" division also. Distal turbidites are largely confined to slate dominated intervals in the Goldenville Formation.

Types 2 and 3 represent classical turbidites and type 1 massive sandstones were probably deposited by currents intermediate between true turbidity flow and grain flow; massive sandstones are common in channelled parts of many ancient submarine fan deposits.

Beds with sharp upper surfaces do not correspond with classical turbidites, but are believed to represent modifications of types 1-3 above. Two processes were responsible for this modification (Fig. 5).

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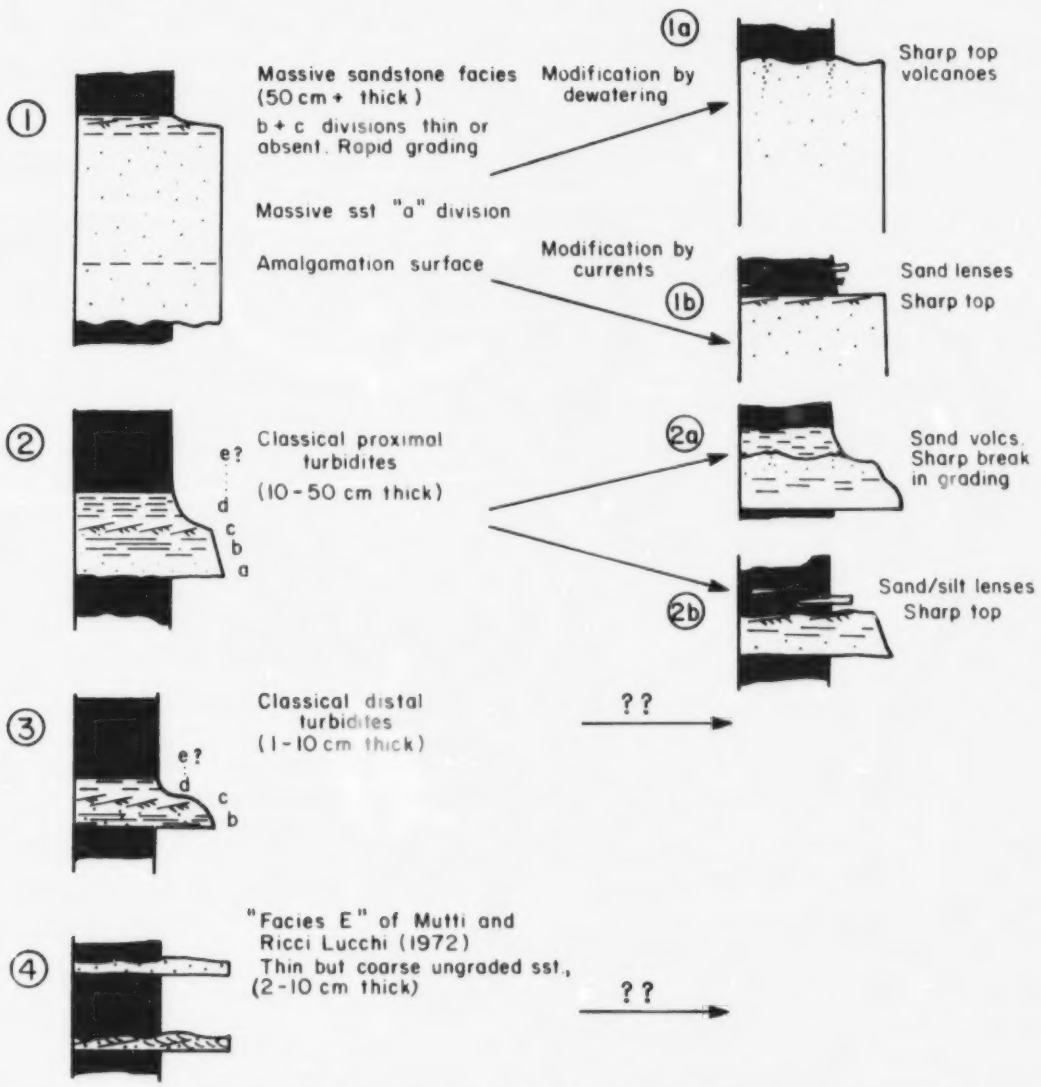

Figure 5. Diagram to show typical Goldenville Formation sandstone layer types.
Left: Layers typical of submarine-fan turbidite deposits generally.
Right: Layers modified by dewatering and current reworking.

a) **Dewatering:** water escaped from rapidly deposited sands, transporting sand grains upwards through the layers and sometimes depositing them in small (5-20 cm diameter) sand volcanoes on the upper surface. Graded silt and mud (now slate) were deposited above this surface.

b) **Reworking by bottom currents** produced sharp, rippled top surfaces overlain by slates containing isolated starved ripples and discontinuous laminae of reworked sand and silt. Tectonic deformation of the commonly lingnoid ripples precludes systematic measurement of the current direction.

Occasional very thin (2-5 cm) beds of medium to coarse rather well sorted crosslaminated sandstone (Fig. 5) cannot be explained by either of the above processes, but appears similar to "facies E" turbidites of Mutti and Ricci Lucchi (1972), believed to represent overbank or mouth bar deposits associated with submarine fan channels.

Direct observation of the geometry of Goldenville sandstone bodies is not generally possible, owing to the difficulty of correlating along strike between sections. Current directions have low plunge, so that channels, if present, are unlikely to show up in the outcrop pattern. Correlation across an anticline at Indian Harbour suggests that considerable across strike variation occurs in the overall thickness of sandstone packets.

Further indications of channelling are:

i) lenticular and crosscutting relationships at erosive bases of massive sandstones,
ii) abundance of intraclasts at some horizons,
iii) presence of "facies E" sandstones (see above)

Petrographic study of the sandstones is at an early stage. The sandstones are "sublitharenites" containing abundant metamorphic chlorite probably representing original clay matrix. Detrital components include quartz, alkali, and plagioclase feldspar, muscovite, tourmaline, sphene, pyroxene and ?epidote. A number of samples show a strongly bimodal grain-size distribution, with a conspicuous well-sorted component of coarse, well rounded "millet seed" sand. The presence of sedimentary rock fragments as well as quartz grains in this component suggests that the rounded grains are unlikely to have been derived by erosion of an older sandstone; rounding therefore possibly occurred in an eolian environment in the Goldenville source area.

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MINERAL DEPOSIT STUDIES

CONTRASTING GRANOPHILE (Sn:W:Mo:Cu:U) DEPOSITS OF NOVA SCOTIA

A. K. Chatterjee

A fundamental assumption of economic geology is that of a genetic and geochemical relation between the granophile deposit types and the associated granitoid rocks. The concept of "specialized granites" is commonly used in exploration for such deposits with certain element concentrations being taken as indicators of mineralization or the potential for mineralizaton.

The granophile association of Sn, W, Mo, Cu and U in Nova Scotia occurs in the following four distinct groups: W-Mo-Cu, Mo-Cu, Sn-W-Cu (± Mo), and U-Cu (± Ag ± P). The mineralization is enclosed either in the granitoid rocks (intrabatholithic cf. endocontact) or in the metamorphic country rocks within 5 km from the contact with the granitoid rocks (peribatholithic cf. exocontact). The intrabatholithic mineralization varies in form from a linear type with vein infillings or sheet-like bodies to a columnar type in the metasomatized granitoid rocks. The peribatholithic mineraiization occurs as impregnations, as replacement bodies and as net-vein stringers in shear zones in siliceous dolomitic limestone or calcareous pelitic rocks.

W-Mo-Cu association: The W-Mo-Cu mineralization (e.g. Whycocomagh) in Cape Breton Island typically forms a pyrometasomatic aposkarn type of mineralization in the regionally metamorphosed Precambrian siliceous dolomitic limestone of the George River Group.

The skarnization and metallization was a two stage process. The first stage produced largely an anhydrous mineral assemblage characterized by granoblastic, Ti-rich andradite (Ad_{60}-Gr_{37}), clinopyroxene of the diopside-hedenbergite series (Di_{95}-Hd_4 to Di_{85}-Hd_{14}), forsterite, ilvaite, spinel and sphene. During the second stage (fluorothermal) the earlier formed minerals were corroded and replaced by talc-antigorite-tremolite assemblage together with an assortment of accessory minerals typified by fluorite, fluorapatite, fluorphlogopite and chondrodite.

Geochemically, the anhydrous skarns are of uniform character and mass balance calculations indicate that a large introduction of Si, Ti, Fe, K and Al has taken place in the siliceous dolomitic limestone during skarnization. During the fluorothermal stage, though the aposkarns do not show significant changes in the bulk chemistry, the level of concentration and the ratios of various metallogenic elements show marked changes. These changes include the introduction of H, F, Cu, Mo, Sn, Co, Ni and Ag together with other trace elements.

The mineralizing solutions were internally generated fluids, derived from cooling of the I-type, polyphase granitoid complexes whose trace element concentrations do not fall within the limits of the metallogenetically specialized granites. However, these are characterized by a large percentage dissimilarity in trace element concentrations. The cal-

culated values are W 68%, Mo 92%, Cu 74%, F 48% and H 39%. In comparison, the calculated values for barren granitoid complexes of Cape Breton Island are W 6%, Mo 4%, Cu 2%, F 10% and H 16%.

Cu-Mo association: The Cu-Mo association occurs in intramagmatic typically I-type polyphase granitoid complexes (e.g. Coxheath, Gillis Mountain). The mineralization is largely confined to shear zones and also in vein swarms and stock work. Petrologically, the complexes are represented by gabbro, diorites, monzodiorites, hornblende granodiorites, granites and minor quartz porphyry.

Geochemically the hydrothermally altered rocks are extremely heterogeneous and the variation diagrams are complex. However, it appears that the gabbro together with diorites and granite form a single magmatic series with a well defined geochemical trend. The other igneous suite with which the mineralization is spatially associated, is characterized by geochemically specialized K-rich quartz diorites, Na-rich granodiorites and Na-rich granites.

Microprobe studies of alteration minerals indicate that hydrothermal pyroxene, amphibole, and biotites are magnesium rich and titanium poor when compared to magmatic silicates from the same, or similar rock types. The distribution and composition of chlorite, sericite and epidote are not always related spatially to the mineralization. The alteration-mineralization zonation is characterized by increasing Mg/Mg+Fe ratios in biotite, amphibole and pyroxene towards the mineralized veins.

In comparison to the barren diorites and granites, the mineralized plutonic complex, at least at Coxheath, is specialized in B, S, Co, Ni, Cr, Cu, and Zn. Also, when compared to the metallogenetically specialized Devono-Carboniferous granites of southern Nova Scotia and Hercynian Europe, the metallogenic specialization of ferrous metals in the granitoid complexes hosting Cu-Mo mineralization is clearly a departure from the predicted behaviour of these elements in the grainitoid complexes.

Sn-W-Cu-(±Mo) association: This type of association typically occurs in an endo-contact environment forming various types of greisens (e.g. East Kemptville, Long Lake, Wedgeport) and also as polymetallic veins in an exo-contact environment (e.g. Plymouth).

The mineralization is typically represented by cassiterite -wolframite-chalcopyrite association together with large assortment of accessory sulphide and oxide minerals which include sphalerite, bornite, arsenopyrite, tetrahedrite, ilmenite, pyrite, pyrrhotite, and hematite in a gangue mineral assemblage of white mica, albite, topaz, beryl, fluorite, fluorapatite, triplite, cryolite, phenakite and bertrandite.

The mineralization is spatially and genetically related to highly differentiated Di>90 2-mica leucogranite complexes of Devono-Carboniferous age. The granitoid complexes include biotite granite, sericitized granite, albitized granite, and various types of greisens. The typomorphic features of the constituent minerals of the granitoid rocks include Co/Ni ratio of pyrite, compositional variation of plagioclase feldspars, lack of equilibrium between coexisting micas, and crystallo-

chemical typomorphism of cassiterites and sphalerites. The trace element concentrations in the 2-mica leucogranites fall well within the limit set for the metallogenetically specialized granites associated with the granophile deposits of Hercynian Europe.

U-Cu (± Ag ± P) association: The U-Cu (± Ag ± P) association (e.g. Millet Brook, East Dalhousie, Gaspereau Lake) typically occurs in closely spaced en echelon pods and lenses confined to shear and fracture zones in the granitoid rocks of the South Mountain batholith. The host rocks range in composition from granodiorite to leuco-adamellites.

The uraniferous shear zones are characterized by strong wallrock alteration and mineralogical changes include albitization, muscovitization, biotitization, chloritization, K-fedspathization and carbonitization. The ore mineralogy is dominated by pitchblende, torbernite, autunite and minor amounts of chalcopyrite, bornite, galena, covellite, chalcocite, sphalerite, and wolframite. The associated gangue minerals are quartz, feldspars, micas, illite-smectites, fluorapatite, andalusite, tourmaline, chlorites, carbonates, pyrite, garnet, Mn-oxides, and anatase.

It is suggested that the formation of uranium mineralization was related to late stages of felsic magmatism and the mineralizing solutions were initially internally generated fluids which evolved through borothermal and carbothermal stages as end-members in a spectrum of deposits formed by the action of thermal fluids.

EDUCATION AND PUBLIC AWARENESS PROGRAM

H. V. Donohoe Jr.

The Mineral Resources Division of the Nova Scotia Department of Mines and Energy has a wealth of information about the geology and mineral resources of the Province. However, a large number of people either do not know about this information or do not understand it. The audience for our information generally has been scientists or technical people. The Department has defined a need for an education and public awareness program to supply easy to understand technical information to the general public and other government agencies.

The benefits of such a program are an increased awareness of the geology and mineral resources of the Province. The Department and the mining and exploraton industry will benefit by a better image. Hopefully this will mean a larger source of informed people and organizations in discussing such problems as mining, land use planning, and science education.

Over the last three decades the Department has produced a large number of pamphlets and general interest articles about the geology and mineral resources of the Province. These publications went out of print or were never updated so that at present there is very little nontechnical information. The Department has recognized this need and has begun to develop a program of pamphlets, maps, brochures, resource material for schools, and courses.

A course entitled "Prospecting and Geology in Nova Scotia" is being offered during the fall term through the Dalhousie University Part Time Studies and Extension Department. Support for the course has come from the Nova Scotia Department of Mines and Energy, Department of Geology of Dalhousie University, and the Chamber of Mineral Resources of Nova Scotia. The instructors are Howard Donohoe of Nova Scotia Department of Mines and Energy and Peter Wallace of Dalhousie.

Other projects to be developed and completed over the next half year are a geological history of Nova Scotia and a history of mining in the Province. The Department is working with the Nova Scotia Museum and the Atlantic Geoscience Society to produce cooperatively, general interest publications.

COAL EXPLORATION IN THE SYDNEY COALFIELD IN 1982

D.J. MacNeil

TRACY SEAM

The Tracy seam was investigated for near surface coal on that portion of the seam lying between MacDonald Lake and Broughton (Fig. 1), a distance of 3.5 km.

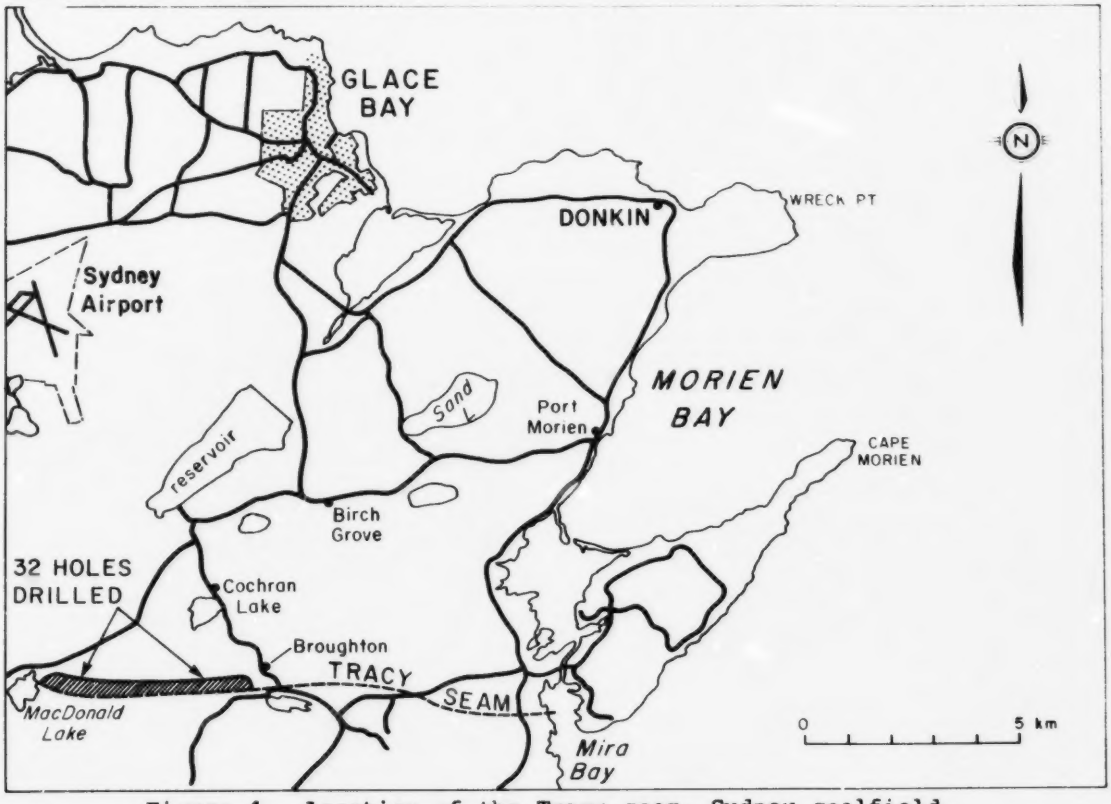

Figure 1. Location of the Tracy seam, Sydney coalfield.

The seam was intersected by 25 holes during the 1982 field season with 812 m being drilled at an average of 32 m per hole. The program was designed to complement the preliminary drilling program carried out in 1978 which consisted of seven holes on the western end of the Tracy seam.

The results of drilling have shown that approximately 1.2 million tonnes are available for surface mining at a strip ratio of 12.5:1. The seam averages 1.2 m in thickness, exhibits a 9° dip to the north and has an ash content of 12 per cent and a sulphur content greater than 6 per cent. The calorific value is 12 800 Btu/lb.

West of MacDonald Lake, the Tracy seam deteriorates both in thickness and quality. To the east open-pit mineable reserves are limited by underground workings at Broughton and by the appreciable thicknesses of glacial overburden (20-30 m) encountered overlying the Tracy crop.

GARDINER SEAM

A near surface coal resource had been outlined east of the Sydney airport in 1981 (Fig. 2). In this area a 3.2 km strike length was drilled and 1.2 million tonnes of coal were outlined on the Gardiner seam using 4.5° dip at a 12.5:1 strip ratio. The seam averages 95 cm in thickness with 11.6 per cent ash and 3.3 per cent sulphur. An "as received" calorific value is 13 170 Btu/lb. The seam deteriorates in quality eastward.

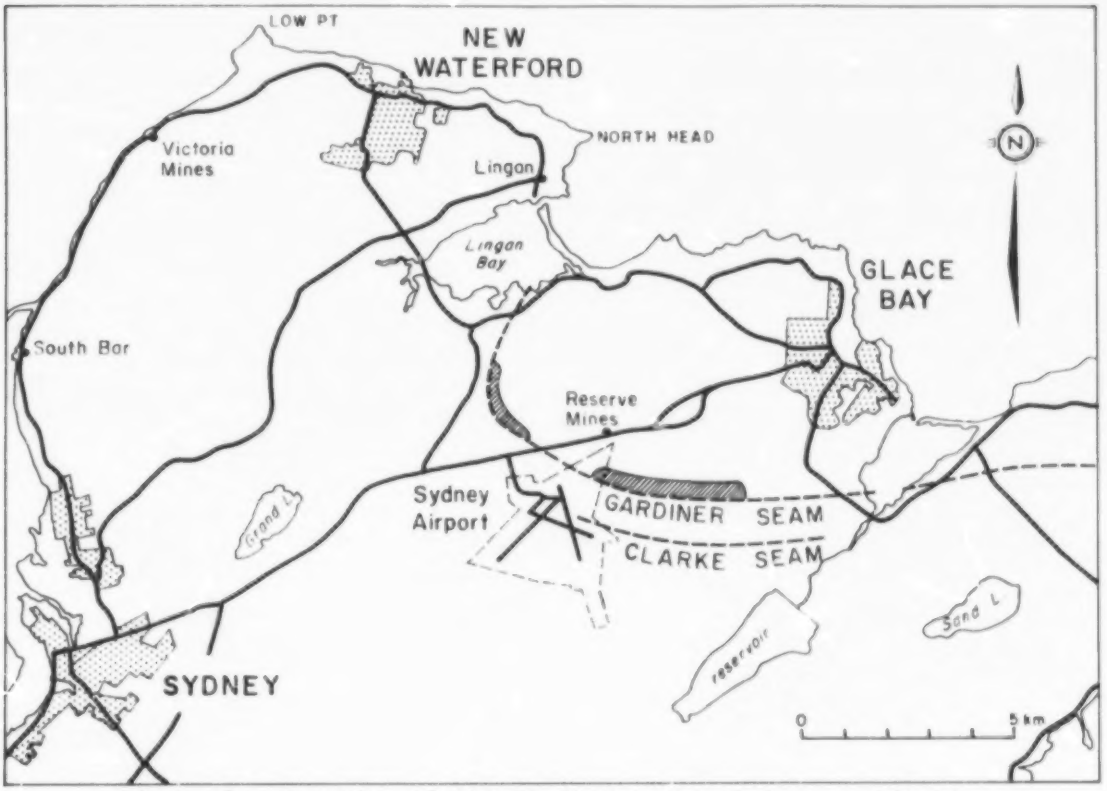

Figure 2. Location of the Gardiner seam, Sydney coalfield.

In addition to the Gardiner a second seam, the O'Dell, overlies the Gardiner seam by 6 to 9 m.

The O'Dell seam averages 1.5 m in thickness, but is characterized by its variability with abundant shaly partings and mudstone splits. It deteriorates westward. Sulphur ranges from 6 to 10 per cent and ash is generally greater than 20 per cent. Since extraction of this seam is concomitant with that of the Gardiner, the possibility of beneficiation of the O'Dell should not be overlooked.

During the 1982 field season, three fill-in holes were drilled on the O'Dell and Gardiner seams for a total of 104 m.

MISCELLANEOUS

Two holes were drilled in 1982 to test the Upper Lorway or Clarke seam which crops approximately 1 km south (structurally below) of the Gardiner seam (Fig. 2). Only a coaly shale horizon was intersected in a mixed red and grey shale-sandstone sequence. No recoverable coal is considered to be in this area.

STUDIES IN THE SPRINGHILL COALFIELD

J. H. Calder and R. Naylor

During the past year investigations in the Springhill coalfield have fallen into three catagories: 1) diamond-drilling of selected targets; 2) mapping within the Novaco open-pit mine; and 3) preparation of an overview paper on the Springhill coalfield. 1982 has been significant because of the return to mining in the coalfield after 12 years of inactivity. A brief summary of these investigations follows.

EXPLORATION ACTIVITIES

The five target areas investigated by diamond-drilling are:

1) the Rodney seam on the anticlinal axis (both at depth and near surface),

2) the No. 3 seam (upper and lower leaves) north of workings in the No. 3 mine,

3) the Nos. 6 and 7 seams, north of workings in the Nos. 6 and 7 mines,

4) coal-bearing strata beneath the No. 6 seam,

5) coal seams (Nos. 6 and 7) outcropping east of Springhill at Lloyd's slope brook.

On the Rodney seam, four holes (SH61-SH64) with a total depth of 1152 m were successfully completed. These drillholes were aimed at better defining and expanding measured resources downdip from areas investigated during the past two years. Five drillholes (SH65-SH69) totalling 331 m were drilled in and around the Novaco open-pit mine on the Rodney seam.

Drill crews were employed at the No. 3 upper and lower leaves, north of workings on those leaves. Drillholes SH70-SH72, totalling 316 m, delineated the depositional margin of the No. 3 seam in this area, effectively eliminating this site as a potential open-pit resource. Drilling proceeded on the Nos. 6 and 7 seams, also north of workings. Drillholes SH73 and SH75, totalling 126 m, intersected favourable coal, however, the steep dip in this area has necessitated closer scrutiny of its mineability. Therefore, drilling has been temporarily suspended at this location in favour of exploration on the little-known coal seams at Lloyd's slope.

A second drill came on site in September and has completed one 288 m hole (SH74) in strata beneath the No. 6 seam at the No. 6 mine. It is currently engaged in the drilling of a 1200 m hole in Leamington in an attempt to correlate drillholes SH8 and SH9 with deep holes on the Rodney seam.

MAPPING WITHIN NOVACO OPEN-PIT MINE

Mapping was conducted from May through August 1982 in the Novaco open-pit mine of the Rodney seam. A 1:500 structure map was completed

after detailed mapping and considerable time spent in deciphering the chronological sequence of faulting within the structurally complex north half of the open-pit, now mined. The sequence of faulting, is as follows:

Episode	Category	Trend
C	6) thrust fault	060° to 110
	5) bedding plane faults and	NA
	4) minor normal faults	040°
B	3) normal cross faults	110°
A	2) scissors fault and	020° to 040°
	1) major normal faults	010° to 038°

The sequence generally decreases in relative magnitude from Category 6 to Category 1. In addition to structural studies, due to excellent exposures, insight was gained into the nature of cyclic multi-bed sandstones and other strata comprising cyclic bed sequences within the coalfield.

OVERVIEW PAPER ON SPRINGHILL COALFIELD

An overview of the geology of the Springhill coalfield, intended as a summary paper to acquaint geologists and mining personnel with various aspects of the coalfield, is now in preparation. Topics discussed include:

a) regional stratigraphy,
b) structural geology,
c) stratigraphy and correlation of coal seams including changes in seam nomenclature,
d) coal petrography and environment of deposition including identification of the megaflora collected by various geologists,
e) a preliminary geological map of the Cumberland coal basin.

Publication is expected in the spring of 1983.

PEATLAND INVENTORY

A. R. Anderson and W. Brougham

INTRODUCTION

Peat represents a safe, clean, indigenous energy resource and has become one of the main options in many countries around the world to reduce their dependency on foreign oil. The production of energy from peat has been a long established technology in northern Europe where it is used as a fuel for steam generation in the production of heat and electricity. Only within the past decade or so has peat been recognized as a viable local energy resource in North America. Canada and the United States have been carrying out research complementing work in Europe to upgrade the production of energy from local reserves.

Information on organic soils extracted from the soil surveys of each county in Nova Scotia (Nova Scotia Soil Survey Reports, 1945-1973; Canada Department of Agriculture and Nova Scotia Department of Agriculture) indicates that the peat resources of the Province are in the range of 160 000 ha.

In stride with Nova Scotia's goal for energy independence, the Energy Resources Division has been engaged in a program since 1979 to assess the peat resources of the Province with emphasis on the availability of peat as a fuel for thermal generation.

Peat deposits can be found in almost all regions of the Province, however, there are several areas where considerable concentrations of peatlands occur (Fig. 1). The largest of these areas, located in southwestern Nova Scotia, contains approximately 38 000 ha of peatland. Other large concentrations are located in Guysborough County and eastern Cape Breton Island.

AREAS INVESTIGATED

Southwestern Nova Scotia

This area was first investigated during the summer of 1980. As of September 1981, a total of 10 119 ha of peatlands had been classified representing 209 million m^3 of in situ peat. Relative tonnages at 50 per cent moisture content (50% M.C.) are in the order of 12.6 and 23.4 million t of horticultural grade humifications (H1-4) and fuel grade humifications (H5-10) respectively.

These tonnages indicate that 65 per cent of the peat investigated in this area to date is within the fuel grade humifications (H5-10) (Table 1).

In addition it is estimated that 4000 ha of peatland have been investigated as of September 1982. Specific figures on these deposits are not available at present, however, this could represent an additional 8.5 million t (50% M.C.) of fuel grade peat bringing the total for the area somewhere around 32.0 million t.

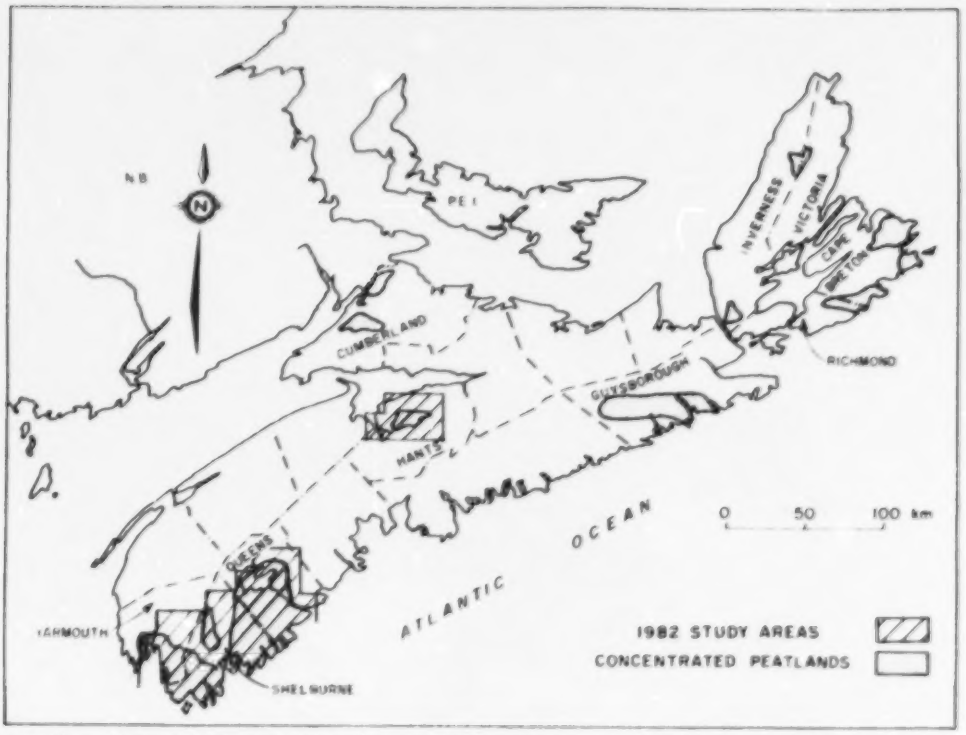

Figure 1. Location map showing peatland areas in Nova Scotia and the 1982 study areas.

Halifax County

During the summer of 1981, specific deposits in Halifax County were assessed to provide information for possible horticultural peat production. Five deposits totalling 255 ha of peatland and 6.8 million m^3 of peat were investigated. Relative tonnages (50% M.C.) for horticultural grade peat (H1-4) and fuel grade peat (H5-10) are 0.89 and 0.13 million t respectively. These figures indicate that 87 per cent of the peat classified in this area is within the horticultural grade humifications (H1-4).

Hants County

This area was first investigated during the summer of 1982. As of September 1982 a total of 2237 ha of peatland representing 80.0 million m^3 of in situ peat had been classified. Relative tonnages (50% M.C.) for horticultural and fuel grade peats are 7.45 and 5.51 million t respectively. Of the peats classified in this area, 43 per cent fall within fuel grade humifications (H5-10).

OTHER STUDIES

During the summer of 1982 a study of meteorological factors related to peatland exploitation methods was completed. Factors such as

Table 1. Summary data

Year Investigated	Area Investigated	Average Depth (m)	Total Area (ha)	In Situ Volume million m^3			Million Tonnes at 50% M.C.*			Per Cent Fuel Grade via	
										Volume In situ	Tonnes 50% M.C.
				H1-4	H5-10	Total	H1-4	H5-10	Total		
**1980	Southwestern Nova Scotia	1.92	3614	29.2	44.8	74.0	4.3	8.5	12.8	61	67
***1981	Southwestern Nova Scotia	1.79	6505	56.8	78.4	135.2	8.3	14.9	23.2	58	64
***1981	Halifax County	3.06	225	6.1	0.7	6.8	0.9	0.1	1.0	10	13
1982	Hants County	3.24	2237	51.0	29.0	80.0	7.5	5.5	13.0	36	43
1982	Southwestern Nova Scotia	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

*Tonnes at 50% moisture content have been calculated using the following conversion factors:

H1-4 peat 0.146 t per in situ m^3
H5-10 peat 0.190 t per in situ m^3

These values have been abridged from: Montreal Engineering Co. Ltd. (1980)

**Anderson and Broughm (1981)
***Anderson and Broughm (1982)
NA - Not Available

wind speed, humidity, temperature and rainfall have been studied and a report comparing various regions in the Maritimes is expected by 1983.

Some investigations of the peat deposits in the Aylesford area, Kings County, were also carried out in 1982. This information will soon be made available.

The possibility of producing a computer classification of all the peatland in the southwestern Nova Scotia study area using satellite data in conjunction with field investigation data is currently being considered. It is expected that information gained from such a classification will result in a more comprehensive report on the peatlands of Nova Scotia.

SUMMARY

To date the Peatland Inventory Project has investigated an estimated total of 16 500 ha of peatland representing a volume of 370 million m^3 of in situ peat. This equates to 25 and 38 million t (50% M.C.) of horticultural grade and fuel grade peat respectively. Actual volumes and ratios for peat deposits studied during the summer of 1982 are still under revision and will be available in the summary report for 1982 (Anderson and Broughm, in preparation).

No further investigations are planned in the southwestern Nova Scotia or the Hants County study areas. Studies are planned for both Guysborough and Cape Breton Counties in 1983.

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OIL AND GAS EXPLORATION REVIEW

ENERGY RESOURCES DIVISION

D. J. MacDonald

Petroleum exploration and related activity increased sharply over the last year both offshore and onshore.

OFFSHORE

With the signing of the Canada-Nova Scotia Agreement on Offshore Oil and Gas Resource Management and Revenue Sharing in March 1982, direct control of the offshore became the mandate of the federal government. The Nova Scotia Department of Mines and Energy, through its Petroleum Directorate, continues to monitor the offshore activities and provide recommendations to the Canada-Nova Scotia Offshore Oil and Gas Board.

This calendar year saw the completion of two additional gas discoveries: Mobil et al Venture B-43, and Petro-Canada et al Banquereau C-21. In this same period, the following five new wells were started: Mobil's Olympia A-12 and South Venture O-59; Petro-Canada's North Banquereau I-13 and West Esperanto B-78; and Shell Canada's Shubenacadia H-100.

Under the Agreement, offshore licence holders sign exploration agreements with the Canada Oil and Gas Lands Administration (COGLA) for a predetermined level of activity. These agreements will result in vigorous evaluation of the offshore over the next three to six years. During this period there will be a minimum of 37 new wells drilled by Bow Valley, Dome, Mobil, Petro-Canada, and Shell. More drilling should evolve with the surrender of approximately 50 per cent of the current 104 835 km^2 of land under licence.

ONSHORE

The interest in petroleum potential onshore has increased over the past year as well. The Department received applications for petroleum licences covering 207 229 ha in addition to the 2 525 583 ha currently under licence. Sedimentary basins having petroleum potential cover approximately 8851 km^2.

Although no drilling has occurred this year, geophysical programs covering approximately 1850 km have been initiated. These investigations may delineate areas favourable for drilling.